



Gender and Interdisciplinary Education for Engineers – GIEE 2011

*Does Interdisciplinary Education improve the gender balance
and attract more young people in Engineering and Technology higher education?*

Abstracts

Formation interdisciplinaire des ingénieurs et problème du genre GIEE 2011

*Des formations d'ingénieur interdisciplinaires peuvent-elles attirer davantage les jeunes et en
particulier les jeunes femmes ?*

Livret de résumés

Attracting more young people, particularly women, in Engineering and Technology (ET) is a major concern in Europe today. Their participation in engineering occupations appears to be a key-issue for European economic and technical development, as well as a central achievement towards gender equality and social justice. Increasing young people interest in the sciences and mathematics and underlining the importance of Engineering and Technology developments in shaping our collective future is an ongoing project in the education sector. In higher education in Europe, women are overrepresented in the humanities, education, arts, health, welfare, agriculture or veterinary studies, while men opt for science, mathematics and computing. If we look more closely at engineering, manufacturing and construction, 18.5% of males graduate in this area, compared to 6.9% of women.

Two factors may explain these differences of choices:

- 1- It seems that the attractiveness of ET sectors differs from males to females because of its gendered representation, which is a masculine one.
- 2- The lack of interdisciplinary content in ET curricula may act as a foil to potential SET students, both men and women. Several previous studiesⁱ suggest, first, that young people and particularly women, want more interdisciplinarity (such as subjects from the humanities and social sciences) in their engineering degree courses; and second, that many non-engineering students may have considered studying engineering if there had been more subjects from the humanities and social sciences included. A more interdisciplinary approach of ET would stress the social utility of ET and the societal challenges attached to the profession, which is something important in students' choice.

Aujourd'hui, attirer plus de jeunes et en particulier des jeunes femmes dans les formations d'ingénieurs est un souci majeur en Europe. C'est une clé pour aller vers l'égalité des sexes et favoriser le développement économique, scientifique et technologique de l'Europe. Accroître l'intérêt des jeunes pour les sciences et la technologie est essentiel pour notre futur collectif et constitue un défi majeur pour l'éducation. En Europe dans l'enseignement supérieur les femmes sont surreprésentées dans les Humanités, l'éducation, les arts, la santé l'agriculture, les études vétérinaires alors que les hommes choisissent plutôt les mathématiques, l'informatique, la technologie, les sciences en général. Si on regarde plus précisément les sciences de l'ingénieur, 18,5% des diplômés délivrés à des hommes le sont dans ces disciplines, mais 6,9% seulement des diplômés délivrés à des femmes.

Deux facteurs peuvent expliquer ces différences dans les choix faits par les jeunes :

1- Il semble que les secteurs de la technologie se caractérisent par une représentation très fortement sexuée qu'en ont les jeunes : la technologie est masculine !

2- L'absence, ou l'insuffisance de contenus interdisciplinaires dans les cursus d'ingénieurs agit comme un repoussoir pour les femmes (comme pour certains hommes d'ailleurs). Des études précédentesⁱⁱ permettent de penser que, premièrement, de nombreux étudiants et étudiantes en sciences de l'ingénieur souhaiteraient plus d'interdisciplinarité (avec des disciplines comme les humanités, les sciences humaines et les sciences sociales) dans leur cursus ; deuxièmement, que beaucoup d'étudiantes et étudiants qui n'ont pas choisi les sciences de l'ingénieur l'auraient fait si les cursus proposés avaient inclus davantage d'interdisciplinarité. En particulier, des cursus plus interdisciplinaires devraient permettre de mettre en évidence l'utilité sociale des sciences de l'ingénieur ainsi que les défis qu'elles doivent relever.

Key Note Speakers

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Full Prof. Structural Mech. (Univ.Florence, 1973/85; Roma La Sapienza, 1985/2010,ret.d. Nov.2010); SEFI “Leonardo da Vinci” Medal for “outstanding contribution of international significance to engineering education”, 2004. Author or co-author of more than 250 papers on several topics of Structural Mechanics, Wind and Earthquake Engineering, and a book (Probabilistic Methods in Structural Engineering, London, 1984). Coordinator or active participant in EC-supported projects and networks on Engineering Education and Accreditation ((H3E, 1997-99; E4, 2000-04; TREE, 2004-08; EUR-ACE, 2004/06; EUR-ACE IMPLEMENTATION, 2006/08; PRO-EAST, 2006/07; LEPAC, 2006/08; EUR-ACE SPREAD, 2008/10; EUGENE, 2009/12). Member of the Engineering Experts’ Group of the OECD-AHELO project (2010- ...). President of ENAEE

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The Bologna Process and transparency in European Engineering Education: increased chances for equal opportunities

Giuliano Augusti

Abstract

It is well known that the “Bologna process” started in 1998 aiming not at uniformity of the various European HE systems, but at creating “a system of easily readable and comparable degrees”. By 2010, this objective has been achieved to a large extent, and the 47-country “European Higher Education Area” (EHEA) has been established. However, not all problems are yet solved and the mobility of students and graduates is still often hampered by lack of trust and/or knowledge of the actual situations: to remove these remaining obstacles will be a great contribution to the increase of equal opportunities for all genders and nationalities.

One of the most important achievements of the Bologna Process has been the development and implementation of specific Quality Assurance (QA) procedures for Higher Education (HE), that at present are in place in most countries of the EHEA, in which National (and in some instances, Regional) QA Agencies for HE have been established, that since 2010 are being listed in a specific European “Register” (EQAR). Most of the QA Agencies listed in the EQAR are “general” Agencies, i.e. deal with all disciplines (and some even with all levels of education, from primary to tertiary). Notable exceptions are the subject-specific CTI (Commission des Titres d’ Ingénieur, France) and ASIIN (Akkreditierungsagentur für Studiengänge der Ingenieurwissenschaften, der Informatik, der Naturwissenschaften und der Mathematik, Germany).

Indeed, QA always includes a self-assessment (“internal QA”) and an “external QA” phase, that can take various forms, the main differences being related to the alternative between “institutional” or “subject-specific” approaches: the first approach is essentially concerned with the educational “process”, while the second alternative implies evaluation of the content of the assessed educational programme, and appears more relevant in particular for programmes leading to a profession, like engineering.

The implementation of QA in HE has led also to reconsider the role and practice of “accreditation”, nowadays a much used word that has several similar but not identical meanings. It is worth quoting the definition of “accreditation” adopted by ENAEE/EUR-ACE, i.e. “a process to ensure suitability of programme as entry route to the engineering profession”, involving “trained and independent panels including academics and professionals”. The word “accreditation” is thus tied to “programme accreditation”, that implies the assessment of not only the academic and scientific “quality” of a programme, but also of its “relevance” for the professional world and the job market. On the other hand, “programme accreditation” does not exclude the “institutional” approach: indeed, the two approaches can usefully complement each other.

However, in a globalized world, “accreditation” should be recognized internationally, especially in the case of professions like engineering. Unfortunately, while recognition of professional qualifications within the EU is guaranteed since 1989 by “Directives” with validity of “laws” (the current “Directive on Recognition of Professional Qualifications” was approved in September 2005), European engineering graduates still suffer from the lack of a European accreditation system of engineering education accepted on the continental scale. The last part of this Lecture will describe an effort for filling this lack: the EUR-ACE system, whose elaboration started in 2004.

As of June 2011, seven national QA Agencies participate in the EUR-ACE system and have awarded approximately 800 “EUR-ACE labels”, testifying that the accredited programmes satisfy a common set of “European Standards”; about the same number of Agencies have applied to join the system and are being assessed by ENAEE, entitled to authorize an Agency to award the EUR-ACE label.

The strengthening and the development of the EUR-ACE system will be small but significant contributions to transparency and transnational recognition of the outcomes of European higher education, hence to the increase of opportunities for all European citizens.

Pr Sue Rosser



Sue Rosser has served as the Provost at San Francisco State University since 2009. From July 1999 – 2009, she served as Dean of Ivan Allen College of liberal arts college at Georgia Institute of Technology, where held the endowed Ivan Allen Dean's Chair of Liberal Arts and Technology. She received her Ph.D. in Zoology from the University of Wisconsin. She has authored and edited thirteen books and written approximately 130 journal articles on the theoretical and applied problems of women and science and women's health. She has held several grants from the National Science Foundation (NSF), including from 2001-2006 serving as co-PI on a \$3.7 million ADVANCE grant. She currently serves as PI on InTEL: Interactive Toolkit for Engineering Learning (\$900,000), and on Bridge to the Future for GIs (\$217,732). She served as a Clayman Fellow at Stanford University (2007-08). She currently serves on the American Association for the Advancement of Science (AAAS) Executive Board, 2010-14

Women in Technology in the U.S.: Glass Ceiling Still Not Broken

Sue V. Rosser

Abstract

During the past four decades, the numbers and percentages of women in the U.S. receiving both undergraduate and graduate degrees in science, technology, engineering and mathematics (STEM) have increased dramatically. Women now receive 50.3% of undergraduate degrees and 40.7% of PhDs in STEM, overall. In contrast, in Engineering and Computer Science, the percentage of women never reached parity and has actually been declining during the last decade at the undergraduate level; women currently receive 18.5% of the bachelor's degrees in Engineering and 17.7% of those in Computer Science.

Building upon the research that documents that women and underrepresented minorities are attracted to engineering when they can see its specific and tangible contributions to society and in bettering local communities, the nation, and the world, an interdisciplinary team at Georgia Tech developed the InTEL project with funding from the Engineering Directorate at the National Science Foundation (NSF), using properties of digital media to create interactive and socially contextualized exercises to support model-based reasoning about Statics. Statics was chosen as the course upon which to focus because it is most students' first introduction to engineering problem solving and serves as the gateway course for the fields in engineering where women have lowest participation. Preliminary results indicate that the digital interactive socially contextualized exercises retain more women to continue in the major.

The small numbers of women majoring in Computer Science and Engineering translate to very small percentages of women in the workforce, particularly in academia, and to attrition at each level of rank and promotion. NSF developed the ADVANCE initiative to encourage retention and promotion of women in STEM in academia. Since 2001, over \$130 million has been awarded to more than 40 institutions to transform policies and practices such as mentoring, data collection, stop-the-tenure clock, recruitment, and entrepreneurial training, to be more supportive of women. ADVANCE does seem to be improving institutional climate, culture, and retention for STEM women in academia, at least in the short term. A caution comes from data suggesting that women may have lower participation in the newer heavily funded areas of translational and technology transfer, especially in information technology (IT), nanotechnology and biotechnology.

Pr Barbara Bagilhole



Barbara Bagilhole has a long and string commitment to Gender Studies and Equal Opportunities and Diversity. She is Professor of Equal opportunities and Social Policy, in the School of Social Sciences, Loughborough University, UK. She has researched and published extensively in the area of equal opportunities and diversity across gender, race, disability, sexual orientation, religious belief, age, and intersectionality. Her latest books are *Understanding Equal Opportunities and Diversity: The social differentiations and intersections of inequality*, (2009), Policy Press; and Bagilhole, B. and White, K. (eds) (2010) *Gender, Power and Management: A Cross-Cultural Analysis of Higher Education*, Palgrave Macmillan. She was a member of the Founding Committee of ATGender, the Professional European Association of Women's and Gender Studies, Feminist Research, Gender Equality and Diversity. She is the current Treasurer of ATGender

A Vision for the Future of European Engineering: Greater gender equality and the utilisation of the skills and talents of all of society

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Abstract

Despite sustained efforts to promote engineering education and careers to young women it remains the most male dominated academic discipline. This paper will briefly set the scene by considering the European wide statistical data on women and technology. It will then report and analyse research on why women do (or do not) study engineering in Higher Education, and then proceed to explore the issues and problems they may confront in an engineering career. It will be argued that these two areas of research are intrinsically linked and that there is a need to take a long-term, holistic approach to reaching a more equitable distribution of engineering across the two genders. It is proposed that the areas that need tackling are: gender stereotyping and self stereotyping by girls and women; family, friends and the media reinforcing of stereotyping; school options and qualifications; careers education and advice; Higher Education & training environments & pedagogy; employment policies and practices; Professional Institutes, membership bodies and networks; and last but not least Government legislation and policy. Underpinning the whole paper is the belief that greater gender-equality could enhance both the education and the profession of engineering, as a desirable aim in principle, but also that women represent an under-utilised resource in the field.

Session 1a

Teaching and Learning Contents and Cultures *Enseignement et apprentissage*

The HELENA project is based on the hypothesis that interdisciplinary training (i.e. a syllabus which includes scientific and technological courses combined with non-scientific subjects like Human and Social Sciences), very often associated with a project and team-based pedagogy, is more appealing to young people and particularly women. What differences does it make in terms of attractiveness? Is the HELENA hypothesis confirmed by the studies conducted on actual trainings existing in Europe?

Enseignement et apprentissage : contenus et cultures. Le projet HELENA est basé sur l'hypothèse que des cursus plus interdisciplinaires (c'est-à-dire des programmes contenant des combinaisons de sujets scientifiques, technologiques avec des Humanités, des sciences humaines et sociales), très souvent organisés dans le cadre d'une pédagogie par projets attirent davantage les jeunes et en particulier les jeunes filles. Cela fait-il une réelle différence en termes d'attractivité ? Y a-t-il d'autres études qui confirment - ou infirment - cette hypothèse ?

Professor Mario Letelier
(Universidad de Santiago, Chile)

Chair of session
Président de séance

Interdisciplinary Teaching and Learning for Diverse and Sustainable Engineering Education

Programmes interdisciplinaires pour une technologie soutenable

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Abstract

For several years now, various stakeholders have argued for more interdisciplinarity in engineering education. However, what exactly is meant by that is still debatable. Beginning in the 1970s, a number of schemes have been set up in engineering faculties to practice multi-disciplinary or cross-disciplinary approaches and yet engineering programmes today retain the aura of a purely technical domain. The social content and context of engineering is still not integrated enough and hardly promoted. The majority of study programmes analyzed in the course of the HELENA project have less than 25% non-engineering subjects and the scope of these is mainly limited to management skills. This paper explores some aspects of how mono-disciplinary engineering has been in the past, what has since changed, some likely reasons for the slow rate of change, and what more can be done to make engineering education more inclusive, diverse and sustainable. Interdisciplinarity not only means bringing non-engineering subjects into engineering education but it also calls for an inclusion of some science and engineering competencies in humanities, social sciences, etc. to enable citizens in general to critically reflect developments in our technological society, to empower them to assess technologies, get engaged, involved and participate in discussions and debates about socio-technological issues. The plea for more informed citizens leads to the necessity of including technoliteracy into non-engineering education as well.

Women in engineering in the UK: approaches to inclusion and engineering curriculum development

Les femmes dans la technologie aux Royaume Uni : accroître le nombre de femmes et faire évoluer les programmes

Sarah Barnard, Barbara Bagilhole, Andrew Dainty, Tarek Hassan

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Abstract

Despite sustained efforts to promote engineering careers to young women it remains the most male dominated academic discipline. This paper will provide an overview of UK data and research on women in engineering higher education, within the context of Europe. Reporting on preliminary findings of a EU-funded project we will discuss how gender inclusion is being addressed in the UK alongside engineering curriculum development and innovation, and how engineering education research is framed in economic or utilitarian, rather than gender-equality, terms. We suggest that the current climate of curriculum innovation is an ideal time to emphasise the importance of gender inclusivity in what is traditionally a male subject area in order to promote a culture of equality and inclusion in engineering higher education.

Influence of the perception of science on Engineering & Technologies study choices in Lithuania

Comment la perception de la science influence le choix d'études technologiques en Lituanie

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Abstract

The paper summarises the Lithuanian specific case studies, providing gender specific data on traditional and innovative pilot degree courses in E&T and identifying innovative study programs in engineering then comparison of traditional and interdisciplinary study courses. For that purpose an in-depth qualitative and quantitative analysis of some engineering study programmes grounded on transnational iterative methodology has been done. From this first analysis, a set of Lithuanian case studies have been selected for further analysis of students' perception of E&T studies. The paper summarises the results found after an in depth examination of these selected case studies for a posterior evaluation of the success of pilot projects in E&T in attracting more female engineering students. The research draw up whether women are more likely than men to study engineering because of its perceived societal and cultural impact, and whether women are more attracted to engineering programs in universities that include an interdisciplinary approach, student-centered learning and the teaching and empowering studies environment.

Key words: study course, traditional, interdisciplinary, gender, E&T.

Gender and Science Studies Competence for Students in Engineering, Natural Sciences, and Science Education. The Project 'Degendering Science' at the University of Hamburg
Le genre et les compétences scientifiques des étudiants en technologie. Sciences de la nature et sciences de l'éducation. Le projet « *désexuer la science* » à l'Université de Hambourg

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Abstract

Gender and diversity studies may attract more students, especially females, into science and engineering. Moreover, teaching the students competence in gender and diversity studies is a way to teach knowledge and skills which engineering and natural sciences students may need in their professional careers. Therefore professional training for science and engineering students should include topics such as social justice, ethics, gender equality, cultural identity, and mechanisms of inclusion and exclusion. It might be a challenge for students coming from a traditional physics or engineering programme to transgress the boundaries and engage with fundamental thinking styles, methods, theories, and concepts of gender and diversity studies. Nevertheless, it will certainly be an

exciting, enriching, and future-oriented challenge, as long as the curriculum and teaching methods keep the target group, their background, knowledge, special needs, and interests in mind.

In this paper I will present my five years experience of the curriculum development project 'Degendering Science' at the University of Hamburg. The project ran between 2002 and 2006 at the borderland of the multidisciplinary Gender Studies Programme, the faculty of Mathematics, Informatics, and Natural Sciences, and the faculty of Educational Sciences. At the project's goals was to change and extend the content and understanding of what the natural sciences are supposed to be. Some syllabi of courses on introductory, advanced, and research level on gender and natural science will be discussed that translated theories of social and cultural studies to the interests and needs of students in science and engineering. Moreover, I will present the evaluation results for 'Degendering Science' and discuss strategies for teaching gender and science studies courses for scientists, engineers, and teachers of science and technology. In presenting this case study I will contribute to the discourse on gender and interdisciplinary education.

Session 1b

Teaching and Learning Contents and Cultures
Enseignement et apprentissage

Professor Henk Zandvoort
(Delft University of Technology)

Chair of the session
Président de séance

Roles that Gender, Systemizing and Teacher Support Play in STEM Education

Rôle du genre, des systèmes et du soutien des enseignants dans les formations scientifiques et technologiques

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Abstract

This study examined the impact of several factors on the decision of 18-19 year old Canadian and Swedish students as to whether or not to enroll in STEM studies at university. Amongst the factors that were examined were: student perceptions of their learning environment in science and mathematics classes; cognitive style (systemizing); learning anxiety; and, intrinsic motivation. A theoretical model of relationships between these factors and the decision to pursue STEM studies was hypothesized. Structural Equation Modeling was used to test the model and its gender invariance. The model was determined to be gender invariant, and suggests that the “gender gap” may in fact in part be a “systemizing gap”. The root causes for any effectiveness of an interdisciplinary approach to STEM education are probably many, but it is likely that overcoming this systemizing gap may be one of them.

Project-Mentoring: a gender-sensitive teaching and learning module in Engineering and Technology with interdisciplinary references

Un projet de tutorat en technologie – un encadrement pédagogique sensible à la dimension du genre et des modules interdisciplinaires

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Abstract

Attracting more young people, particularly young women, into ET, is a key-element in contemporary higher education in Europe. Moreover, the Bologna process, as well as the changing fields of activities for engineers, reveal new challenges in living up to the requirements of change processes in a sustainable manner. Therefore teaching and learning concepts are needed which

- focus on integrative enhancement of interdisciplinary and personal skills
- serve to increase young people's interest in ET and attract new peer groups (particularly women)
- connect theory and their translation into practical action
- sensitize students to self-reflection and life-long-learning
- strengthen school-university networks

Project-Mentoring as one example is based on the mentoring relationship between students (in their role as mentors) and secondary school pupils (in their role as mentees). It combines a classic mentoring approach with technical and engineering projects. The objectives mentioned above are supported by the structure of the module: project seminars (contents among others: interdisciplinary aspects, gender awareness and technical skills), development of individual research topics and projects stimulating individual learning and development processes. *Project-Mentoring* is aimed at secondary school pupils, in order to share the fascination of technology and for them to gain insight into the university. The educational concept, its objectives and curricular integration will be presented, as well as the research design, the empirical findings so far, and their impact on the questions under discussion at the HELENA conference.

The appeal of innovation: New trends in STEM from a gender point of view Rendre l'innovation attirante : les nouvelles tendances dans les formations en ST du point de vue du genre

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Abstract

Innovation is necessary to face the present challenges in society (Europe 2020). We know that new ideas flourish from diversity. Differences between the two genders constitute a fundamental source of diversity in society. A consequence is that society could be more innovative if both genders are equally represented and they are both able to contribute. It is more and more important that diversity of ideas in decisional processes let to develop innovation.

However, She Figures 2009 reveals that women in scientific research remain a minority with a trend present all over Europe: women comprise a majority of the students and about half of the doctoral research fellows in most countries. But only a few of them reach the very top (Badaloni et al, 2008), evaporating in the leakypipe (Badaloni et al, 2010).

This proposal aims to:

- monitor data about the presence of women in different curricula in STEM Faculties, along time, to evaluate possible positive gradient, index of change;
- analyse different curricula, mainly innovative ones more oriented to interdisciplinary domains and linked with life sciences in Engineering Faculty, comparing them with traditional academic courses;
- involve women and men students of different scientific curricula in STEM areas, in order to explore, via questionnaires, their views of Science and Technology, Woman and Man Scientist and their expectations of academic careers.

Thinking Interdisciplinarity in Engineering Education: Challenges for Future Research

Réflexions sur l'interdisciplinarité dans la formation des ingénieurs : challenges pour des recherches futures

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Abstract

The aim of the HELENA project was to test if changing the curriculum towards more interdisciplinarity makes engineering degree courses more attractive to women and changes representations. The aim of this paper is to introduce HELENA methodology, to question “interdisciplinarity” and to provide ideas for future research.

HELENA used pragmatic and provisional concepts based on counting the ECTS after deciding a correspondence between a course heading and the classification into one or more disciplines out of engineering and technology as “interdisciplinary”. In addition, qualitative case studies provided additional information on curriculum and students perspectives on the issue. The lack of conceptual consistence of such a definition made the counting process very tricky, but it provided a starting point. Counting “interdisciplinary” ECTS supposes a clear definition of “discipline”, remembering that disciplines are historical and social constructions in specific contexts. Possible “a-disciplinary” contents as training periods, project work, etc. have to be taken into account too, as well as the curriculum context. How courses are taught and articulated within a coherent (or not) curriculum? Who is teaching? What are the pedagogical issues? Connections with “mode 1” and “mode 2” science and technology (Nowotny & Gibbons) would be helpful. It would mean that the curriculum has to catch up with the new way of doing science, independently of gender issues.

Beyond interdisciplinarity, HELENA raised questions on engineering education and attractiveness. Various “attraction” criteria interfere with interdisciplinarity: prestige or ranking, job perspectives, personal interest. In addition, in recent years, many changes have affected the curriculum as the Bologna process and the broader access to university. The impact of them has to be taken into account to understand the complex dynamics of attractiveness. We must also warn against risks of stereotyping and gendering the disciplines out of S&T as “feminine”. HELENA raised also questions on engineers’ identity: in terms of specialities, degree level, prestige, opportunities, etc. Curriculum and pedagogical strategies may be very different as students’ profiles and motivation may be very different. As a result, comparisons are difficult and we should question how interdisciplinarity impacts in detail the different contexts. We also must re-think the paths to become engineers: students’ paths are less and less linear and we observed students’ demands for more flexibility and mobility, and the role of representations on management, technology etc. Do we re-think engineering education as the quest for a post-modern “honnête homme” or an irremediable loss for S&T?

Keywords: interdisciplinarity, gender, engineering education, disciplines, curriculum, methodology

Session 2

Student's experiences *Le point de vue des étudiants*

This second session present and discuss the perceptions by students (including graduate students), women and men, of interdisciplinary programs in ET education and their social impact. In what way do their perceptions determine their study choices?

Le point de vue des étudiants : Il s'agit de présenter et de discuter la perception qu'ont les étudiants de tous niveaux - femmes et hommes - de tels programmes interdisciplinaires et de leur sens et impact social potentiels. Dans quelle mesure cette perception détermine-t-elle les choix d'études ?

Professor Natascha Van Hattum
(University of Minho)

Chair of session
Présidente de séance

Interdisciplinarity – Students’ Perception of Interdisciplinary Engineering Education in Europe

Comment les étudiants européens perçoivent les formations interdisciplinaires en technologie

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Abstract

Engineering and Technology (E&T) are considered as future job fields, especially in Europe, where human resources and innovative research are regarded as key factors of economical success (European Commission 2008). However, only a minority of young people plans a career in E&T (Becker 2009). For instance, Germany currently lacks 36,000 engineers (Koppel 2011).

Recent studies tried to explain this assumed technology-distance of young people and found out that young generations miss social and environmental aspects in technology (Kruse et al. 2006). Furthermore, it could be shown that young people’s motivation to engage in science can be increased through establishing links to society (Bennett et al. 2003). There are indications that some new popular E&T study programmes like biomedical engineering or information design are successful because they offer students a broader range of contents and values within one study programme. Langen and Dekkers (2005) could show that taking up E&T education is positively influenced by the degree of interdisciplinarity. Moreover, interdisciplinary engineering education is appreciated by companies as well (Freitag 2010, Wächter 2005).

The EU project HELENA explored students’ perception of interdisciplinarity in engineering study programmes. As one result it can be stated that quite many of the interviewed E&T students are in favour of interdisciplinarity, although they do not always name it that way. They would like to have non-technical subjects included in their E&T study programmes, especially those obviously and closely connected to future job fields, like languages, management skills and business contents.

Finally this paper discusses how interdisciplinarity could make a successful difference in engineering education and points out that it is not enough to only add some non-technical subjects to an E&T study programme to make it interdisciplinary, and answers the questions what ‘true interdisciplinary engineering education’ could be like.

Female engineering students: career attractors

Les femmes dans les formations technologiques : les carrières motivantes

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Abstract

While the number of women undertaking studies in disciplines such as medicine, veterinary science and architecture in Australian universities has grown to almost equal that of males, there are still relatively few women in engineering studies. In overall completions women are outnumbered by men 5:1 in Engineering and related technologies. At the same time many industries such as mining, construction and rail are in a growth phase. However, the rail industry, particularly, is not attracting sufficient engineers and skilled technicians from within the Australian labour market and is facing widespread retirements from an ageing workforce. Rail is thus trying to actively attract early and

mid-career engineers and skilled technical workers and is in competition for talent with other industries.

This paper draws data from a completed mixed methods study that explored the factors that attract university and technical college final year engineering students to specific industries and their perceptions of working as an engineer in rail, in particular. An Exploratory Sequential Design informed the research methodology, where focus groups with final year engineering students were followed by a survey of 350 final year engineering students.

The qualitative data revealed some differences in the career attractors for female and male students. The quantitative data revealed similar though not identical career attractors for the female respondents compared to the males. Rail was not seen as an attractive employer and was perceived as having a culture that was 'male, pale and stale'. Most tellingly, what attracted these young women (and men) to engineering careers was not what they perceived rail to offer.

Keywords: Engineering, university, females, rail, career attractors

Students' perception of IT curricula and career opportunities in Serbia and Macedonia

La perception par les étudiants des formations et carrières en technologie de l'information en Serbie et Macédoine

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Abstract

The research presented in this paper aims at investigating gender-based preferences for study choices made by male and female students studying information technology (IT) disciplines based on the methods of identifying and analyzing relevant IT study programmes in Serbia and Macedonia, and analyzing the students' perception of the curricula and career opportunities. The methodology used to perform the research and to analyze the results was developed within the "Higher Education Leading to ENgineering And scientific careers" (HELENA) project. Following this methodology, the IT study programmes from public and private faculties were examined and compared according to the ratio of interdisciplinary content in curricula, number of enrolled students, and success rate of graduated students, while taking into account the gender distribution. Along with this quantitative approach, a qualitative approach was used to observe students' perception on the relevant study programmes and their future career opportunities.

Research results have shown that female students in two countries find studying engineering significantly more attractive than female students in the most of remaining European countries do. Interestingly, although students from these two countries live in similar cultural context, they do express some differences like, for example, the predisposition to research of female students in Macedonia in contrast to male students in Serbia. However, almost all of them agree that their family and friends support them and consider their study choice as the one that will provide them well-paid, respectable and perspective job positions.

Social relevance and interdisciplinarity in Canadian engineering education: Perceptions of female and male students

Importance sociale et interdisciplinarité dans les formations
technologiques au Canada : la perception des étudiantes et des
étudiants

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Abstract:

This paper presents some key results of a large-scale research project funded by the Social Sciences and Humanities Research Council of Canada and by the Professional Engineers of Ontario. Conducted by an interdisciplinary team led by Ruby Heap, the project examines the perceptions of female and male students, professors and administrators about importance of "social relevance" in engineering education. To expose students to the societal implications of engineering work has been identified over the years by several scholars as a means of attracting and retaining more women in engineering education. Others argue that integrating more humanities and social science subjects in the engineering curriculum would help make it more socially relevant. We put these hypotheses to the test by examining the perceptions of female and male students in Canadian undergraduate engineering programs using a mixed methods approach (qualitative and quantitative

Session 3

Other ways to attract women

Y a-t-il d'autres moyens d'attirer les jeunes filles dans les études d'ingénieur ?

This session give the opportunity to present, analyze and discuss other ways to attract more young people, and particularly women, into ET.

Y a-t-il d'autres moyens d'attirer les jeunes filles dans les études d'ingénieur ? Cette session donnera l'occasion de présenter, d'analyser et de discuter d'autres pistes pour attirer les jeunes femmes et les jeunes en général vers les sciences de l'ingénieur.

Pr Giedre Purvaneckiene
(Vilnius University)

Chair of Session
Présidente de séance

The Micropolitics of Disciplinary Summer Universities for Women

La micro politique des cours d'été réservés aux femmes

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Abstract

Although women are highly recruited by German universities in the last years, they are strongly underrepresented in engineering and technology. Universities developed strategies to balance the gender gap. One focused strategy concentrated on single-sex measures for women.

In 1998, the national project 'InformaticaFeminale – Summer University for Women in Informatics' started at the University of Bremen (Germany). The concept of a disciplinary Summer University includes, since its beginning, a place for experimentation, with the intention to develop and imply new impulses in informatics. The aim is to bring together women students and women professors or lecturers from all computer science departments in Germany, women from practice and women from other disciplines to work on new educational concepts in informatics. This context of summer courses gives them the opportunity to try new forms of teaching and learning in an exemplary manner as well as to establish career networks. InformaticaFeminale is established as the only regular single-sex study program at a German research university. The Bremen concept of a Summer University for Women in informatics has been transferred to international sister projects in Austria and New Zealand as well as to a regional summer college in a German Federal Land. As a disciplinary transfer a summer university for women in engineering called 'Ingenieurinnen-Sommeruni' has been developed in Bremen in 2005.

In our paper we give a retrospect of 14 years experience. A subject of our critical observation is the process of feminist institution building by summer universities. In particular, we analyze the participants' influence on inter-/disciplinary directions of curricula and course arrangements, and reflect the concept of Summer Universities as a compensation of lacks in academic further education. The integration of non-typical students in higher education programs in engineering and technology by summer universities is studied. Furthermore, we examine the community development regarding social or career related networking.

Women-only engineering education – a promising Austrian model initiative

Les formations technologiques réservées aux femmes – un modèle autrichien prometteur

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Abstract

Women-only engineering education seems to be a paradoxical but working approach to gain gender equity in engineering (Wetterer 2003, Dahmen 2005). However, single-sex education enables students – here: women – to focus on learning aloof from gender hierarchies. This is especially important in en-gendered fields like technology (Wajcman 2000, Wächter 2003). Gender-segregated schooling has a long tradition in tertiary education: On the one hand, universities had been an

educational arena for men only before women were accepted at universities (around the turn of the 19th century) (Hofstätter 2009). Some engineering courses still have an unintentionally mono-educational tradition due to a lack of female students. On the other hand, gender-segregated schooling for women has a long history in women's colleges in the USA, which have served as an inspiration for some successful younger engineering study programs for women in Germany (ibid.).

In this paper we will present results of a process evaluation study of Austria's first women-only technical college (2008-2010) in Graz (Freitag 2010, Hofstätter et al. 2010). The target group of this post-secondary educational program comprises unemployed women interested in mechanical engineering.

The approach of our evaluation derives from action research which involves frequent feedback during the process in order to allow continuous improvement (Lewin 1947). In this paper results of the process evaluation will be presented against the background of well-known critical and promising factors of women-only engineering courses.

Technical Companies in Switzerland on the way to a corporate culture in line with gender equality

Les entreprises technologiques en Suisse qui commencent à intégrer dans leur culture la dimension du genre

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Abstract

This paper attempts to contribute to how innovative companies can reduce the job market barriers for female engineers, that are still in place in Switzerland even though there is a shortage of qualified workers. Although the conditions seem to be advantageous, empirical studies show that female professionals are challenged by bigger problems than their male colleagues. Not only during their academic studies, but also afterwards in the working environment gender differences arise. Potential female students anticipate these opportunities. The project we present here focuses on how important non-technical knowledge and non-technical competences are for female engineers to create and sustain a gender-just and motivating work environment. Non-technical knowledge, understood here as contextual knowledge and expertise from fields such as social sciences and the humanities, is firstly asked of graduates of the degree programs of engineering (we are looking at the degree programs of electrical engineering, applied organizational computer sciences and mechanical engineering of Universities of Applied Science UAS), and secondly it is expected of women (and increasingly of young men) to acquire these competences during their studies. Additionally, the holistic relation of products and services, a gender-sensitive corporate culture and -structure, and a sustainable communication is viewed as paramount by (potential) employers. Accordingly, the objective of this study was to focus on the perspective of companies (two case studies) on the one hand, and on the perspective of female engineers from the degree programs electrical engineering, computer sciences and mechanical engineering on the other. Varied methods were used to receive the results.

The results show that while functional aspects and motivating tasks are important, non-functional aspects and non-technical skills seem to be of even greater importance for the attractiveness of companies, a motivating work environment and the interdisciplinary education of students. Multiple courses of action are proposed.

Make Engineering and Technology More Appealing to Women via Gender Competence as an Innovative Element of Teacher-Training in Mathematics

Rendre la technologie plus attirante pour les femmes grâce à l'intégration de la conscience du genre dans la formation des enseignants en mathématiques

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Abstract

Results from international comparative studies on students' performance point out that to date school subjects in Germany are divided into gender-specific domains regarding pupils' interests, motivation, academic self-concepts and, partially, achievements. For example, mathematics, unlike languages, is still seen as a "typical boys' subject" (cf. Bos et al. 2008; Mullis et al. 2000; OECD 2001, 2004, 2007, 2010). Such gender-related differences in the preferences for subjects already become apparent at the end of primary school, aggravate in the course of secondary education and become later on manifest in a gender-related choice of field of study and field of occupation. Indeed, some research indicates that mathematics – beyond a relevant school subject and scientific discipline – is also a "core discipline" for the field of natural sciences and engineering (cf. DMV 2007; Heine et al. 2005, 2008; Lewin et al. 2001). Therefore, to encourage more female pupils to choose mathematics as an advanced course at school appears to be a key-issue for attracting more women to the fields of technology and engineering later on. For more than 15 years researchers within didactics and gender-related educational science have emphasized that besides the development and implementation of gender sensitive didactics at school there is also the necessity for sensitizing mathematics teachers to their impact on creating and reproducing gender stereotypes and gender-related differences (cf. Jungwirth 1991; Jungwirth & Stadler 2005; Keller 1998; Keitel 2010). Together with other elements, the lack of gender competence on the part of teachers must be identified as a fundamental reason for the subject-specific gender bias in the development of interests and competences of young people. Thus, prospective teachers need to acquire gender competence with regard to didactics and subject specific contents, in order to overcome gender-specific biases within school subjects. A systematic integration of gender competence in the mathematics teacher-training courses would be a sustainable step towards an increase of equal opportunities for pupils beyond gender stereotyped knowledge and interest domains. In this paper we present the concept, contents and educational objectives of a gender competence course for teacher-training in mathematics. This course was tested during winter term 2009/10 at eight German universities (cf. Mischau et al. 2009, 2010). Afterwards, it has been evaluated and is to be allocated as a transferable tutorial at other universities. Although there are international differences in teacher-training, this course offers suggestions for a gender sensitive teacher-training across cultural boundaries.

Session 4

Policies *Les politiques*

What are the policy recommendations and assessments of existing programs? What evaluation tools exist to measure the effectiveness of such programs? What recommendations can be made to institutions that want to improve their recruitment and, in particular, to attract more women?

Les politiques. Quelles sont les recommandations que l'on peut faire à partir de l'analyse de programmes existants ? Existe-t-il des instruments d'évaluation de tels programmes ? Comment doivent s'y prendre les institutions qui souhaitent améliorer leur recrutement et notamment recruter plus de femmes ?

Dr André Béraud
(ECEPIE, INSA de Lyon)

Chair of session
Président de séance

Interdisciplinarity towards gender equality in engineering and technology education. Recommendations

L'interdisciplinarité comme chemin vers l'égalité des sexes dans les domaines de la technologie. Les recommandations

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Abstract

Equal participation of women and men in engineering occupations is still a major challenge for the European Union. Women participation in engineering appears as a key-issue for European economical and technical development, as well as a central achievement towards gender equality and social justice. In most European countries, female graduates proportionately outnumber male graduates. However, it seems that the attractiveness towards engineering and technology sectors differs from male to female, where the women's share remains very low. The history of engineering education in Europe may impact upon current developments; in particular tensions felt between theories and practice in the curriculum, and between the profession and Higher Education Institutions (HEIs). In this context, interdisciplinary degrees are argued to offer attractiveness to a bigger and diverse student population than single, traditional engineering degrees. The project HELENA, "Higher Education Leading to ENgineering And scientific careers", aims to explore the students' perception and personal reasons for study choice of engineering and technology (E&T), the influence of the cultural or social context in their decision, and to analyze the success of "innovative" study programmes -which include interdisciplinarity- in comparison with the "traditional" ones in attracting more female engineering students.

Starting with a contextual overview of the economic influence, labour market and educational programmes related to E&T, this paper introduces the main findings of the research carried out in HELENA project outlining the overall curriculum analysis and the case studies before turning the attention to gender specific indicators for measuring the attractiveness of engineering and technology study programmes and to explore new possibilities in high education. Finally, with the aim of contributing to encourage, empower and foster women in engineering and technology, the paper provides a set of recommendations addressed to policy makers and educational actors that will enable the HEIs to evaluate the effectiveness of their educational policies and study programmes in attracting more female students to engineering disciplines.

Breaking patterns: How opportunistic sponsorship and women's moral compass shape careers of female scientists

Briser les habitudes : comment un tutorat opportun et un point de vue féminin peuvent aider les carrières des femmes

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Abstract

Women's careers in science and technology fields persistently lag behind those of male scientists. Scientific career success is believed to largely depend on the ability of individuals and groups to establish networks. This study analyzes women's attitudes toward networks and their perception of how social and professional networks influence their careers. This is done on the basis of fifteen life-

story narrations and semi-structured interviews of female researchers and students in science and technology. The material allows rich insights into crucial decision points along female career paths. While the first analysis step focuses on the *gestalt* of the narratives to identify life story patterns, the second analysis step provides an in-depth examination of attitudes towards networks based on distinct story lines. The study brings two different story-telling patterns to light. Despite the diversity in the individual life stories, women narrate their own biographies along the distinction between in-group vs. out-group: The *My Story is Quite Usual* views herself as in-group member and describes her career as the logical consequence of her own merits. The *I am Different* storyteller perceives herself as an out-group member and highlights her token role as a woman in a male-dominated environment. For all women, career sponsors, who grant comprehensive professional support and access to their scientific networks, prove crucial for career advancement. Results also show, however, that women hold rather ambivalent or even negative attitudes towards networking, irrespective of life story pattern, their career stage and their own (positive) experiences with sponsorship and networking. The results indicate the need for institutionalized mentoring programs, reducing personal dependencies on (opportunistic) sponsors, and diversity programs to foster social integration. Additionally, the study contributes critical arguments highlighting a dysfunction within scientific networks which tend to further homophilous ties.

Women Presence in Engineering in Spain: Causes and Measures to Attract more Women.

The case of the Polytechnic University of Madrid (UPM)

Les femmes dans la technologie en Espagne ; les causes du problème et les mesures à prendre pour en attirer davantage. Le cas de l'Université polytechnique de Madrid (UPM)

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Abstract

In spite of the significant changes observed in the last decades in women insertion in the working world, data shows, however, a very low inclusion of females in technological areas, especially in engineering and architecture worldwide. Within this trend, Spain is a clear example.

This paper focuses on the presence of women in technical education studies in Spain, and more specifically, it draws on the case of the Polytechnic University of Madrid.

The technical education in Spain, although present for more than two centuries, was organized as higher education in the last decades of the 20th century. The Polytechnic University of Madrid, founded in 1971, was the first University to bring together different engineering degrees, which had had a long tradition in Spain. At the starting point, these technical studies did not offer much attraction to women, and indeed, they were a great challenge in which, the difficulties encountered greatly exceeded the advantages they could provide for women.

During the last decades of the 20th century, the presence of women in engineering studies was still very scarce. Presently, at the Polytechnic University the figures of female students have steadily increased, however, they are still far from the aimed gender equality balance.

At the Polytechnic University of Madrid, almost 70% of the students are male, however, differences can be observed in the various areas: whereas the number of women in industrial and aeronautical engineering studies for example, is extremely little, there is a greater number of women students in the field of environmental studies, and females outnumber the male students in architecture.

The study presented here is two folded: firstly, it analyzes the evolution of students in the Spanish University and compares it to the Polytechnic University of Madrid to state the unbalance female

representation in engineering studies. Secondly, after analyzing the possible causes (social, educational, traditional...), we present various measures and strategies implemented in the last years trying to mitigate this unbalance, and outline short and long term tools and action plans to increase the recruitment of women in the engineering sectors.

Keywords

Women presence, women in engineering, Spain, gendered discrimination, female inclusion in science and technology.

Changing the face of STEM: The example of computer science in Germany

Changer le visage des sciences et de la technologie : l'exemple de l'informatique en Allemagne

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Abstract

In an initial evaluation step in order to screen a school of computer science, first year students of computer science were asked to complete a questionnaire. The results form the basis for an actual status analysis which offers a clear view on the composition of the target group its reasons for the decision to study computer science and their expectations accompanying this choice. They lead to first hypotheses regarding the identification of gender equal indicators in this school.

Gender Counts?!

Analysis of Student Dropout at Vienna University of Technology

Le sexe joue-t-il un rôle dans les arrêts d'études à l'Université Technologique de Vienne ? Analyse des données

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Abstract

Vienna University of Technology (VUT) has an extremely high student dropout rate of more than 50 percent in its curricula. This study analyses whether and to what extent socio-demographic factors increase the dropout risk at VUT. In particular, the study analyses whether academic integration, measured by several performance indicators, decreases dropout for male and female students in the same way when other factors such as the field of study, age and nationality are controlled. The analysis is based on data from active students enrolled between 1998 and 2010 in thirteen science and technology disciplines. Logistic Regression models estimating the dropout risk for the entire student

population show that women face a substantially higher dropout risk than male students. Logistic Regression models for male and female subsamples further show, that academic integration does not reduce the dropout risk for female students to the same extent than it does for male students. Policy makers are well advised to consider diversity aspects in designing curricula and principles of teaching. In order to attract and retain high potential candidates it is necessary to support their social integration at VUT.
