International Journal of Gender, Science and Technology

http://genderandset.open.ac.uk

In association with the Internet Interdisciplinary Institute, Open University of Catalonia

The Problem in the Eye of the Beholder: Working with Gender Reforms in Computer Engineering

Minna Salminen-Karlsson

Uppsala University, Sweden

ABSTRACT

The article investigates problems in making computer engineering education more gender-inclusive. The two models which have been used to explain the dearth of women in computer engineering education are presented. The first one, mainly used by computer engineering faculty as a basis for a number of measures designed to recruit more women, is based on gender differences among students. The second one, mainly used by gender researchers, is based on an examination of the educational and cultural context of computer engineering education, and in particular its underlying values and ethos. With its starting point in the gender research model, the article discusses the difficulties of cooperation between gender researchers and engineering faculty in relation to working together on the problem of few women in computer engineering education. In addition to differences in perspective, additional issues such as language and status differences are discussed.

KEYWORDS

Engineering education; disciplinary cultures; educational reform; engineering culture; gender and ICT.

The Problem in the Eye of the Beholder: Working with Gender Reforms in Computer Engineering

INTRODUCTION

Gender researchers and computer engineering educators have one potential issue of common interest: the low percentage of women attending computer engineering programmes. This 'woman problem', known in practically all Western countries, is continuously verified by statistics. But when looking at the graphs and figures of the representation of women among computer engineering students, computer engineering educators and gender researchers see different problems. This is also evident in the research done in the area by computer scientists, on the one hand, and those social scientists, particularly in Europe, who do research in gender and technology, on the other (Singh et al., 2007). This difference is highly relevant in those still quite rare cases where computer science faculty wish to use the competence of a gender researcher in addressing 'the woman problem' in their own programmes.

Such a situation is the starting point of the present paper. It consists of reflections on a situation in which I – a long-time researcher and lecturer in the area of gender in (computer) engineering education – was invited to help an institute of technology in gender mainstreaming their programme in computer engineering.

The Swedish Background

The paper is written from a Swedish perspective. Although the references are international (meaning, with some exceptions, the ordinary English-speaking part of the world), my frame of reference when writing is Swedish. The article deals with computer engineering education, which here means the Swedish Master of Engineering programme with a computer engineering major. However, the differences between similar programmes across different countries do not appear to be large.

The conception of gender problems in technical and scientific education in Sweden reached a landmark in the mid-1990s, when a governmental agency financed five large reform projects for creating woman-friendly technical education (Wistedt, 1998; Salminen-Karlsson, 1999). Two of those projects concerned engineering programmes in information technology. This initiative, and the following state-financed initiative to renew engineering programmes in general, became well-known and have affected the general view on the issue of gender in engineering education. From the viewpoint of higher education authorities, the problem is seen, to a certain degree, as something that engineering departments are responsible for and that can be affected by instructional methods and subject content.

In the Swedish context, the politically correct way of viewing gender equality is to say that a gender mix benefits both women and men. Measures such as mentoring, which single out the female students, do exist, but are not seen as the primary solution in a societal context where equality measures are based on the idea of the similarity of men and women, rather than the differences between them. In general, working on gender issues does not have high priority at computer

engineering departments, and the changes and innovations that are made most often are the work of a few enthusiasts.

TWO WAYS OF SEEING 'THE WOMAN PROBLEM'

Computer Engineers' View

There are still quite a number of teachers in computer engineering who believe that the problem is about information, that girls are misinformed and that if they could only be made to understand the rewards of a career in computer science, the percentage would rise. There are also those who believe in innate differences or differences grounded in early childhood, and see the disinterest of girls in computer engineering as natural and inevitable in that light. Such attitudes have partly been replaced by the insight that, given the differences between girls and boys, computer engineering education should make changes and amendments to also accommodate women. However, even among the engineering educators who hold this view, the problem and the remedies perceived are still largely in the phase described as 'add women and stir'.

In studies made by computer engineering educators the differences between male and female engineering students have been verified, and continue to be highlighted (West & Ross, 2002; Ogan et al., 2006; Carter, Jernejcic & Lim, 2007, Lewis, Lang & McKay, 2007; Singh et al., 2007; Alkhalifa, 2008; Powell, 2008; Johnson, Stone & Phillips, 2008; Rosenbloom et al., 2008; Cheryan et al., 2009). Women's interests, self-esteem, ability and learning styles are found to be problematic, and there are also remedies that have been tried and described in a number of publications. Thus, it is thought that the problem of women's non-interest in computer science can be overcome by broadening the field, stressing the applications of computing rather than computing itself, and stressing the social parts of working as a computer professional (West & Ross, 2002; Margolis & Fisher, 2003; Jeschke et al., 2007). Another suggestion is that the problem of women often having less previous knowledge of computing and programming can be overcome by offering them hands-on courses and by avoiding any hidden expectations of previous knowledge when designing the course (Margolis & Fisher, 2002; Fox, Sonnert & Nikiforova, 2009). Different teaching techniques have also been shown to diminish the difference between men's and women's achievements (Mbarika, Sankar & Raju, 2003; Lewis, McKay & Lang, 2006). It is also thought that the problem of women having lower self-esteem as computer scientists can be overcome by giving more positive feedback (Shull & Weiner, 2002.) Some of these studies also touch on the issue of identity, by stressing the importance of female role models in the environment (Cohoon & Aspray, 2006; Sonnert, Fox & Adkins, 2007).

What such measures do, however, is to reproduce women as different from the norm. The studies in which women as a group are compared with men as a group start from the assumption that women and men are different and that the overlaps are not interesting. As long as the problem is viewed in this way, there will be two groups to relate to, and one of them will present the norm and the other the exception to the norm, the problem to be solved (Sturman, 2009). The view of female students as a homogenous unknown in the eyes of computer science faculty

is illustrated by Rasmusson and Håpnes's (1991) study at a computer science department, where different groups of male students could be identified in the faculty members' talk, but women were seen as a unified category of their own. However, using a different approach, quite a lot of variation could be found among both men and women when it comes to interest, ability, self-esteem and identity.

Gender Researchers' View

The departments and people in computer engineering who rely on the research on female students' special needs and who work along those lines have come a long way, from thinking about 'changing the girls' to 'changing our education' to fit the female students. Computer engineering education can certainly be improved along these lines, and there is still a great deal to be done. However, as a gender researcher, I have a profoundly different view of the problem. While the problem, to a computer engineer, is women being different from ordinary computer engineering students, I, in the tradition of research on gender and technology, see the problem as computer engineering being different from the parts of higher education (or the professional areas or the areas of life) that are attractive to women. In the perspective of a computer engineer, computer engineering is normal and women are an anomaly. In my perspective, the areas of life that women are interested in are normal and computer engineering is an anomaly. This is not to say that I regard computer engineers as 'weird geeks', only that I regard computer engineering education as a particular practice that in many ways excludes different kinds of people, among them a large number of women. Thus, to come to terms with the women issue, the measures should have their starting point not in the special characteristics of women, but in the special characteristics of computer engineering education.

One of the aspects that lies beyond the approach where the characteristics of women are seen as the problem, is the concept of masculinity. Instead of only looking at the female students, a gender researcher also looks at the men, both male students and male faculty – and even the necessity for women in the context to perform masculinity. This perspective is based on the assumption that both men and women, who have been socialized in the masculine environment, unconsciously and sometimes even unwillingly, perpetuate practices that have their rationales in an outlook on the world that is common among Western, white, middle class men, both because of their earlier experiences and because of the demands of their present (male-dominated) working environment. Among these practices, people with other experiences and, thus, other ways of seeing the world (not only women but, for example, men belonging to minorities, Frieze et al., 2006 and Carter & Jernejcic & Lim, 2007) may find it difficult to feel at ease.

A number of studies taking this more cultural view (Rasmussen & Håpnes, 1991; Grundy & Grundy, 1996; Salminen-Karlsson, 1999; Margolis & Fisher, 2002; Lagesen, 2003; Wilson, 2003; Björkman, 2005; Cohoon & Aspray, 2006; Varma, Prasad & Kapur, 2006; Sturman, 2009; Godfrey & Parker, 2010) have shown how computer engineering education is excluding on different levels: daily interactions, educational practices and general ethos. In all of these spheres, the education has

been and continues to be dominated by men, and thus, it is quite natural that characteristics and mechanisms that exclude women are perpetuated.

In Sweden, ideas about how university departments contribute to women's problems in computer engineering education have spread from the sphere of daily interactions to penetrate even parts of the sphere of educational practices. Today, there is some awareness, in a number of computer engineering departments, that it is not only the rowdy or geeky fellow students and possibly an occasional, old-fashioned misogynous teacher who are the problem at the university level, but that the way teaching is done or how courses are planned can also increase or reduce women's interest in studies in the area. However, even these departments are generally still a long way from seeing the problem against the background of the general ethos of computer engineering. And those engineering educators who have tried to adopt a more culturally based view have often found that the changes made to create a programme better suited to what are perceived as female students' preferences run against deep seated cultural values in the computer engineering ethos. This makes them difficult to enforce and, above all, sustain.

The Ethos of Computer Engineering

Social scientists' cultural perspective always comes back to the ethos, the underlying values of computer engineering education. This is in contrast to studies about women in such programmes conducted by computer engineering educators themselves, where this value system is not elaborated on, even if the effects of its extreme features on the 'woman problem' may be mentioned. This is natural, as it is difficult to get a view of a culture from the inside, and it is particularly problematic for computer engineers, whose education does not include training in observing and reflecting on such issues as human behaviour.

There are outsider descriptions of this culture. Godfrey and Parker's (2010) description of engineering culture fits to some extent, even if they themselves state that software engineering is different, and that overall generalizations are difficult to make, as cultures are always located in time and place. However, much of what they describe in engineering education in general can also be found in accounts of computer engineering: valuing the practical (meaning that ethics, values and such are not interesting unless perceived as important in the concrete work situation); using language for information and not for reflection; valuing hardship as a marker of an elite education; believing in the gender and value neutrality of the engineering endeavour; having a mastering attitude to time; and, feeling as an elite compared to many other educational programmes. Godfrey and Parker mention several traits that make an engineer, for example, toughness (in a psychological and not physical sense), withholding one's emotions, and having a careless attitude to dress and appearance. Margolis & Fisher (2002) describe the passion for computers that is seen as natural in the computer science environment. They also reveal that a large proportion of students do not ascribe to this passion – an example of how cultural myths prevail regardless of the real characteristics of the environment. Even Rasmussen & Håpnes (1991), in their study of a computer science department, found that the cultural values of the passionate hacker students were trend-setting at the department, in spite of the teachers officially

denouncing them. Klawe (2001) states that, in the value hierarchy of computer science, abstractions have a much higher position than applications. Grundy & Grundy (1996) write about the same issue using the expression 'messiness of everyday life', which computer scientists are taught to abstract and simplify when writing applications. Comparing international and U.S. students, Margolis & Fisher also find the belief in the 'geek gene' in the American environment – that computing is something you do or do not have an innate ability for, that some people are right and others are not right from the beginning.

Several of these studies point out that women are often marginalized in this culture. This is partly because they have different values and thus do not feel at ease with the behaviour in which these values are manifested. A number of the traits that make a computer engineer run counter to what women, according to the common expectations in our society, are supposed to be like. But women (and a number of men) can also easily be marginalized because the individualistic values of computer engineering make it relatively easy to marginalize people. For example, if women do not always achieve as well as men do, they may be seen as lacking the geek gene, and as being better off somewhere else.

The computer engineering ethos can be described with words such as individual excellence, logic, reasoning, abstractions, obsession for computers, self-righteousness, lack of reflection and masculinity. These concepts are often laden with negative connotations. They are not a very good starting point when communicating with computer engineering educators about what aspects also underlie the problem of the low percentage of female students. It is not a particularly good idea to come from the outside and tell people that one sees their ordinary way of viewing the world, presenting themselves and interacting with each other as problematic. What, then, is a gender researcher, who ascribes to the cultural view, to do when asked to consult in reforming computer engineering education?

COOPERATING IN REFORMING COMPUTER ENGINEERING EDUCATION

The idea that there is a solution to every problem is part of engineering thinking, and a gender researcher in this case is asked to contribute to solving the problem of too few women. There is often also a widespread feeling of resignation after previous unsuccessful efforts to solve the problem. The easiest way of taking on the task is to start from the problem definition of the computer engineers: contributing to the work with knowledge of inclusive teaching methods; repeatedly pointing out the need to consider the possible exclusiveness of the subject content on different levels; and, recommending and designing different kinds of support activities for female students. This is what is expected. This is also in accordance with the engineering way of thinking – operationalizing the problem and finding a step-by-step solution to it. It will certainly make the education better – even if the measurable effect, more women in the programme, may be modest or even non-existent.

However, a gender researcher encompassing the cultural view will feel a bit dubious about this approach. It may improve the education, but as long as the reforms are

not supported by the overall culture at the department, they run the risk of vanishing, for example when the initiators – often there is one or a few enthusiasts who are influential enough to start a gender reform – disappear from the context or become interested in other things. For a change to be sustainable, there has to be a critical mass of academic staff who can see the gender aspects in the subsequent changes made to the educational programme, and for whom it is natural to guard an ethos of inclusivity. For a reform to last, there has to be a number of people who are able to see particularities in their professional culture, who realize that just by doing things in a way that is self-evident and natural for them, they can exclude others, and who are able to detect such instances and willing to speak up about them. Thus, a gender researcher would probably like to foster a number of such people, who will still be working at the department when she has left the scene. Ideally, by that time, the problem of too few women would have transformed into a desire to broaden the recruitment over all, to make the education hospitable, not only to women, but also to different categories of men.

Problems in Implementing Gender Knowledge in Computer Engineering

Gender research – a fuzzy cloud in the horizon

The characteristics of computer engineering education imply that the culture is not very receptive, particularly to advice from outsiders. An outsider needs legitimacy, and to be listened to, she needs some knowledge of the language that is understood by computer engineers. We have here the problem of two very different academic cultures (Becher, 1989), one of which has a higher status. Between them there is a breach, and not only a breach but a certain amount of active distancing on both sides. When it comes to gender, the mere cultural differences can also be mixed with visible or invisible resistance to gender equality. Equality is a power issue, and those who are advantaged by the status quo on the different levels of daily interactions, educational structures and ethos, will often react in some way when changes that promote other groups are suggested. This resistance is not always easy to distinguish from problems prompted by the differences in the cultures, particularly when resistance is not politically correct, but has to work in subtle ways. Those computer engineering educators who want to promote gender inclusivity in their study programmes may make considerable efforts to cross the breach, while a resistance to gender equality may, for example, take the form of criticism and incomprehension of gender research.

The social sciences are a vague and unchartered terrain somewhere behind the horizon at a computer engineering department – a terrain often considered not worth exploring. What is known about social science (it is common to refer to social science in the singular, thus not acknowledging the diversity of the area) is that it is fuzzy and most often does not have practical implications. (There are exceptions, for example, studies that relate to computer use and computer users and thus have practical value – at least if they are "scientifically" conducted. Qualitative research is not very well regarded in this context). At best there is an acceptance of the social sciences as 'different'. The differences between cultures, when it comes to reforming education, are exemplified by Borrego (2007) in her description of the difficulties of engineering educators interested in engaging in educational research. With their background in engineering science, they had problems in understanding

such fundamentals of educational research as the need for an explicit theoretical starting point, problems of transferability or the existence and applicability of different research methods.

When it comes to gender studies, the situation is even more problematic. Among many academics, gender research is often seen as an extreme form of social science which is politically and ideologically tainted, and this is also true in regard to computer engineering educators. Wahl (1999) explains how important it is to make explicit the differences between gender research and our everyday ideas about gender and the political goals of feminism, even when lecturing for academics.

Only trustworthy knowledge is useful knowledge, and numbers are the signallers of trustworthiness in the engineering world. While qualitative studies can function as an eye-opener and add flavour to the message, numbers legitimate discussion. All quantitative studies are interesting and important. Unfortunately, most gender researchers, in particular after the postmodern turn, are not very keen on numbers.

Language

The problems of language are easily underrated. They exist both on the general level of communication and on the level of vocabulary. Computer engineering is not a reading and writing culture, and the way gender research uses language in argumentation and reflection is foreign to that culture. Björkman (2005), in listening to conversations between computer scientists and engineers on gender issues, reacts to what she describes as vagueness in the conversational style of gender researchers. She also reflects on the vocabularies of gender research and computer science, in a project in which computer science teachers actually read and discussed a number of gender research texts together with gender researchers. Some central concepts have quite different meanings in those two cultures, which makes understanding gender research complicated for computer scientists. Her examples include such central words as 'problem', 'understanding' and 'construction'. To social scientists, problems are an object of investigation, but need not necessarily be solved, which is very different from the engineering approach. To a computer engineer, understanding is not a general verb, in the same sense that a social scientist uses it, but is tightly connected to problem-solving. Construction, likewise, is more tied to practical work, constructing according to certain instructions, while to a social scientist it refers to a much more creative endeavour. There are a number of concepts like this that both cultures use, but in different ways.

Thus, while a criticism of texts of gender research by computer engineers may be an expression of passive resistance to taking up gender issues in education, it may also be an expression of the real difficulties in taking in information of a form and a language that is unfamiliar. It is not easy to find texts that take up gender issues on structural and symbolic levels in a language and style that is easily accessible to engineering educators. For a gender researcher, writing such a text would risk simplifying matters to an extent that would arouse heavy (and well-founded) criticism from her fellow researchers. The widely referenced book on the problem of

few women in computer science, Margolis & Fisher's *Unlocking the Clubhouse* (2002), is a product of cooperation between an insider and an outsider. It is understandable and largely acceptable to both groups (however, Sturman, 2009, criticizes it for being normative). It treats the structural and symbolic issues to some extent, but without the background of gender theory that would enable an understanding of the issue – in the gender research sense of the word.

Power, status and disrespect

The problems for computer engineering educators, as regards taking in what a gender researcher wants to communicate, are also related to the status and power relations between different academic disciplines. Many gender researchers not only regard interpretive research or postmodern perspectives or other features that are foreign to engineering as more in line with their preferences for doing research, but also as an improvement on positivist research and, thus, as inherently better. (Oakley, 2000, criticizes this development, which she regards as unduly narrowing gender research and making it less useful in communicating with institutions that could make changes in gender relations.) Starting from such a standpoint, it is easy to look down on academics who criticize gender research from a positivist perspective, and who have problems, not only with understanding and accepting, but even with reading gender research. This may be accentuated by the ordinary power relations – representing a discipline that often is questioned, a gender researcher may feel the need to assert the qualities of her discipline rather than showing due respect for the discipline of her collaborators. Thus, a situation in which gender research meets computer engineering education can become a situation characterized by disrespect from both sides.

When starting on a reform project with computer engineers, a gender researcher has the choice of complying with the demand to come up with tips for how to change the educational practices to make them more attractive to female students, or trying to make it possible for people in the environment to look at a broader spectrum of their everyday practices and maybe even the foundations of their discipline through gendered eyes. Might it be possible to begin by providing tips and then, gradually, broaden the scope to include other aspects as well?

Björkman's (2005, and personal communication) experiences do not encourage this. Making the leap from seeing gender as a pedagogical problem, which is solved by adding some new teaching methods and subject content, to seeing gender as an inherent part of everything that is going on at a department, whether women are present or not, seems to be difficult. Moving from the pedagogy to the culture requires a fundamentally different problem definition, and there is little reason to believe that knowledge about gender-inclusive teaching will automatically pave the way for an interest in and an ability to look at one's own culture. As gender relations are also power relations, the leap is all the more difficult – being aware of gender relations leads to being aware of power relations, and those are not always very comfortable. Thus, hoping to start with teaching tips and to end with a cultural view may not be very realistic, if the basic assumptions and the direction are not made clear from the beginning.

Incomplete but Workable Translation between Gender Studies and Engineering: An Example

Even if the cultural approach speaks of masculinity as a concept rather than male students and faculty, the dichotomization into women and men, female and male is always a risk, particularly when working with gender in engineering education, where categorizations are an inherent and unproblematic part of the culture. To avoid the 'othering' of female students even in the reform work – with the good intention of improving their situation – it is important that gender not be seen as a concept that is divided into two deadlocked categories.

When lecturing to engineering faculty it has thus been important for me to point out the overlaps between the groups of 'men' and 'women'. The first few years of lecturing I started by introducing a graph of overlapping bell curves, stressing that when I was talking about men and women, I talked about the two sides of the middle, both containing women as well as men, though in different proportions. However, when moving more and more into not talking about female and male students, but about the culture of engineering, the bell curve figure became less satisfactory.

For some years I have, instead, used a scale: A horizontal rectangle, purple in one end and green in the other, with the colours gradually mixing, with a 50-50 blend in the middle. One end represents masculinity, the other end represents femininity, but most of the scale represents mixtures of masculinity and femininity. I normally present the graph in the very beginning of a lecture. However, I have best experienced its usefulness in situations where I have been discussing, rather than lecturing. When I introduce the scale at some point during a discussion, I get an understanding, my fellow discussants start referring to it and the discussion becomes more open and less focused on the 'woman problem'.

Thinking of both people and phenomena as more or less masculine or feminine is more complicated than simply dividing them into two categories, even if it still is not as open as gender researchers would like to see the issue. When starting from a purely dichotomous perception, thinking in degrees as a first step is easier than using gender researchers' broad idea of gender as performance or gender as 'doing', which opens up for a multiplicity of interpretations. Using a continuum does not make gender as simple and dichotomous as computer engineering teachers are used to seeing it, but because the dichotomous perception still underlies it, it is conceivable enough to help in structuring the discussions a gender researcher with a cultural view sees as inevitable.

What characterizes the endpoints of a masculinity-femininity scale may differ, depending on the national and departmental culture, and even the personal opinions of those doing the defining. Results of gender research may be used in this phase. Once there is some kind of agreement on the endpoints, a simple graphic device of the masculinity-femininity scale may be used repeatedly. It can serve as a reminder of the differences between different female as well as different male students. It can also be used when discussing where on the scale students need to be today to feel comfortable, and what kind of students will be or will not be

welcome in the future. This is quite important: a common starting point is the desire to attract more women and maybe fewer 'nerdy' men, but when probing deeper into the issue, there may be limits to the degree of femininity that is welcome. In these discussions, the educational programme itself can also be placed on the scale, for an agreement on how much the suggested reforms may move it towards the feminine end. This will help in defining realistic goals for a reform, and also in pursuing discussions with opponents who fear that the image of the programme will suffer too much from becoming more feminine.

A graphical masculinity-femininity scale can also be used when discussing the issue with female students, to open up the complicated identity issues to some degree. Placing oneself on a graph is easier than having to choose one of two gender positions, and the realization that one's position on the graph is not fixed, but can be changed, both in a longer time frame and depending on the different situations in which one acts, gives more freedom to see oneself as both masculine and feminine. Placing both the educational programme and oneself on the scale can help in reflecting on the discrepancies between the two.

CONCLUSION

The paper does not set out to help the reader better understand 'the woman problem'. It only presents two different understandings, originating from two different contexts, and the problems of their communication – thus, hopefully, increasing understanding between all those people of good will who are working to solve the problem, on the level of higher education.

The different stories of people who have worked with introducing a gender perspective in computer science and their experience that change is extremely slow and that resistance, even when subtle, is very powerful, should probably have made me weary. However, thinking positively, there are still people who are troubled by the problem and who continue working at it. Because we are approaching the problem from different angles, we will work on it in different ways. We still do not have a complete comprehension of the problem, and we still do not know which measures are the most effective. Our reasons for working on the problem also vary, from tapping the entire talent pool, or giving women possibilities for rewarding careers, to the conviction that, given the enormous importance of ICT in our society, its creation and development should not be left in the hands of a group who is self-selected on the basis of characteristics other than their competence in answering the challenges created by the possibilities of ICT and, more importantly, the challenges posed to ICT by the global society.

I represent one of the possible views on the problem, owing to my disciplinary background and my perspective on gender issues. In my view, computer engineering educators still have a great deal to learn from gender studies in their efforts to solve the problem of too few women in their educational programmes – including their definition of the problem in those terms. However, for a number of years, I delivered lectures on gender-inclusive teaching to engineering faculty - and I hope that I did some good. Now, taking one step further, I can see the difficulties of those representatives of computer engineering education who, as far as I can

judge, sincerely want to both engage more female students and advocate the careers of female faculty, when it comes to accepting that the problem does not necessarily have a ready solution. In my view, improving women's participation in computer engineering is a long-term commitment and the path cannot be laid out from the very beginning. It is not even certain, given the societal context, that any improvements in the education will notably increase the number of female students who choose to enter a programme – what I can hope for is that changing the culture of computer engineering education will make it more welcoming to a larger variety of students, women and men, if they choose to enter it.

This is not good news for the reformers who are eager and hopeful to solve the problem and have asked for my help in doing it. We will have to compromise and to respect each others' view on the problem, and the ways of dealing with problems in general. As a gender researcher, I will have to accept an operational problem definition and an operational goal – though perhaps rather expressed in terms of retention than in terms of enrolment – and be able to relate all actions to that goal. As computer engineering faculty, my collaborators will have to accept that we are still at an experimental stage in solving the problem, and that the solutions may require different and more profound actions than they have envisioned. Together, I hope, we will be able to both create a computer engineering programme that is more inclusive and learn even more about the possibilities and the difficulties involved in the interdisciplinary cooperation of gender studies and computer engineering.

REFERENCES

Alkhalifa, Eshaa M. (2008) Sequential Programming Instruction and Gender Differences. *IEEE Transactions on Education,* 51 (4) 417-422.

Becher, Tony (1989), *Academic tribes and territories: intellectual enquiry and the cultures of disciplines*, Milton Keynes, Society for Research into Higher Education

Björkman, Christina (2005) *Crossing boundaries, focusing foundations, trying translations: feminist technoscience strategies in computer science*, Karlskrona, Blekinge tekniska högskola.
http://www.bth.se/fou/forskinfo.nsf/all/ba43f85b96bff20bc1257003005d1dd3/$file/inlaga_christina_bjorkman.pdf

Borrego, Maura (2007) 'Conceptual difficulties experienced by trained engineers learning educational research methods', *Journal of Engineering Education,* vol. 96, no 2, pp. 91-102.

Carter, Lori, Jernejcic, Luke and Lim, Nicodemus (2007) 'Success in CS: Is culture a factor?' *37th Annual Frontiers in Education Conference, Global Engineering: Knowledge Without Borders – Opportunities without passports. Proceedings – Frontiers in Education Conference*. pp. 360-365.

Cheryan, Sapna, Plaut, Victoria C., Davies, Paul G. and Steele, Claude M. (2009) 'Ambient Belonging: How Stereotypical Cues Impact Gender Participation in

Computer Science' *Journal of Personality and Social Psychology,* vol. 97, no. 6, pp. 1045-1060.
http://www.comp.dit.ie/dgordon/Courses/ILT/ILT0010/AmbientbelongingHowstereotypicalcuesimpactgenderparticipationincomputerscience.pdf

Cohoon Joanne M. and Aspray, William (2006) 'A critical review on women's participation in postsecondary computing education', in Cohoon, J.M. & Aspray. W. (eds) *Women and information technology. Research on underrepresentation*, Cambridge, Mass., MIT Press.

Fox, Mary F., Sonnert, Gerhard and Nikiforova, Irina (2009) 'Successful programs for undergraduate women in science and engineering: adapting versus adopting the institutional environment', *Research in Higher Education*, vol. 50, no. 4, pp. 333-353.

Frieze, Carol, Blum, Lenore, Hazzan, Orit and Dias, Bernardien M. (2006) 'Culture and Environment as Determinants of Women's Participation in Computing: Revealing the "Women-CS Fit"'. *Proceedings of the SIGCSE Tech. Symp. On Computer Science Education (SIGCSE '06),* pp. 22-26.

Godfrey, Elisabeth and Parker, Lesley (2010) 'Mapping the cultural landscape in engineering education', *Journal of Engineering Education,* vol. 99, no 1, pp. 5-22.

Grundy, Frances and Grundy, John (1996) *Women and computers*, Oxford, Intellect.

Jeschke, Sabina, Dahlmann, Nina, Pfeiffer, Olivier, Schroeder, Christian and Wilke, Leticia (2007) 'Challenge diversity: New curricula in natural sciences, computer science and engineering', *37th Annual Frontiers in Education Coinference, Global Engineering: Knowledge Without Borders – opportunities without passports. Proceedings – Frontiers in Education Conference, 2007,* pp. 632-637.

Johnson, Richard D., Stone, Dianna L. and Phillips, Nichole T. (2008) 'Relations among ethnicity, gender, beliefs, attitudes, and intention to pursue a career in information technology', *Journal of Applied Social Psychology,* vol. 38, no. 4, pp. 999-1022.

Klawe, Maria (2001) 'Refreshing the nerds', *Communications of the ACM*, vol. 44, no. 7, pp. 67-68.

Lagesen, Vivian Anette (2003)' Advertising computer science to women (or was it the other way round?)', in Lie, M. (ed) *He, she and IT - revisited,* Oslo, Gyldendal.
Lewis, Sue, McKay, Judy and Lang, Catherine (2006) 'The next wave of gender projects in IT curriculum teaching at universities', *ACM International Conference Proceeding Series,* vol. 165*,* pp. 135-142.

Lewis, Sue, Lang, Catherine and McKay, Judy (2007) 'An inconvenient truth: The invisibility of women in ICT', *Australasian Journal of Information Systems,* vol. 15, no. 1, pp. 59-76.

Margolis, Jane and Fisher, Allan (2002) *Unlocking the Clubhouse: Women in Computing*, Cambridge, Mass., MIT Press.

Mbarika, Victor W., Sankar, Chetan S. and Raju, P.K. (2003)' Identification of factors that lead to perceived learning improvements for female students', *IEEE Transactions on Education,* vol. 46, no. 1, pp. 26-36.

Oakley, Ann (2000), *Experiments in Knowing. Gender and Method in the Social Sciences*, Cambridge, Polity Press.

Ogan, Christine, Robinson, Jean C., Ahuja, Manju and Herring, Susan C. (2006) 'Gender Differences among Students in Computer Science and Applied Information Technology', , in Cohoon, J.M. & Aspray. W. (eds) *Women and Information Technology. Research on Underrepresentation*, Cambridge, Mass., MIT Press.

Powell, Rita M. (2008) 'Improving the persistence of first-year undergraduate women in computer science', *SIGCSE'08:Proceedings of the 39th ACM Technical Symposium on Computer Science Education.* Pp. 518-522.

Rasmussen, Bente and Håpnes, Tove (1991)' Excluding women from the technologies of the future? A case study of the culture of computer science', *Futures,* vol. 23, no. 10, pp. 1107-1119.

Rosenbloom, Joshua L., Ash, Ronald A., Dupont, Brandon and Coder, LeAnne (2008)' Why are there so few women in information technology? Assessing the role of personality in career choices', *Journal of Economic Psychology,* vol. 29, no. 4, pp. 543-554.

Salminen-Karlsson, Minna (1999) *Bringing Women into Computer Engineering. Curriculum Reform Processes at Two Institutes of Technology,* Linköping, Linköping University.

Shull, P.J. and Weiner, M. (2002) 'Thinking inside the box. Self-efficacy of women in engineering', *International Journal of Engineering Education,* vol. 18, no. 4, pp. 438-446.

Singh, Kusum, Allen Katherine L., Scheckler, Rebecca and Darlington, Lisa (2007) 'Women in computer-related majors: A critical synthesis of research and theory from 1994 to 2005', *Review of Educational Research,* vol. 77, no. 4, pp. 500-533.

Sonnert, Gerhard, Fox, Mary Frank and Adkins, Kirsten (2007) 'Undergraduate women in science and engineering: Effects of faculty, fields, and institutions over time', *Social Science Quarterly,* vol. 88, no. 5, pp. 1333-1356.

Sturman, Susan M. (2009) *Women in Computing as Problematic: Gender, Ethics and Identity in University Computer Science Education,*Toronto, University of Toronto.
https://tspace.library.utoronto.ca/bitstream/1807/18333/1/Sturman_Susan_M_200911_PhD_thesis.pdf

Varma, Roli, Prasad, Amit, Kapur, Deepak (2006) 'Confronting the ''socialization'' barrier: cross-ethnic differences in undergraduate women's preference for IT education', in Cohoon, J.M. & Aspray. W. (eds) *Women and information technology. Research on underrepresentation*, Cambridge, Mass., MIT Press.

Wahl, Anna(1999) 'The Cloud - Lecturing on feminist research', *NORA - Nordic Journal of Feminist and Gender Research*, vol. 7, no. 2, pp. 97-108.

West, Margaret and Ross, Susan (2002). 'Retaining females in computer science: A new look at a persistent problem', *Journal of Computing Sciences in Colleges,* vol. 17, no. 5, pp. 1–7.

Wilson, Fiona (2003)' Can compute, won't compute: women's participation in the culture of computing', *New Technology, Work and Employment,* vol. 18, no. 2, pp. 127-142.

Wistedt, Inger (1998) *Recruiting Female Students to Higher Education in Mathematics, Physics and Technology: An Evaluation of a Swedish Initiative*, Stockholm, Swedish National Agency for Higher Education.
https://guoa.ub.gu.se/dspace/bitstream/2077/19296/1/gupea_2077_19296_1.pdf