In search of female IT-students

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Abstract. This article looks at the problem of retaining female students in IT educations. It is argued that there are changes to be made at the university were the male domination is resulting in a limited approach to teaching IT both with regard to content and methods. Emphasis on more modern teaching methods and application of technology is needed as well as elimination of female hostile attitudes. The findings are based on a literature review supplemented with results from a work shop with students from a technical university.

Introduction

There is a lack of female IT-students as well as female employees within the IT field in most northern European countries such as the Scandinavian countries, United Kingdom and USA (Pleeger and Mertz, 1995 – in Ahuja, 2002). This is seen to be a problem both in relation to the working force (where there is a need for more skilled technology workers) (Ahuja, 2002) and in relation to resulting IT products (software/hardware) with a high risk that it is only suitable for half of the population (Computerworld, 2007). In Europe more than 300.000 qualified IT

personnel is missing within in the IT branch. This branch contributes to more than 25% of EU's total growth and therefore it is seen as a tremendous problem (COMON, 2008).

Denmark follows the above-described trend closely. Currently, there is a fierce competition between the universities for female IT students. The trend is clear: Women do not want to study hard core IT while they are more than happy to study IT put into a broader relation such as business, communication and health care (Computerworld, 2007). On the mixed educations, the uptake of women, generally, in Danish universities in 2007 were almost 60% (Computerworld, 2007) – while on the hard core education lines less than 5% were women (Computerworld, 2006).

When looking at the IT sector it has a strong reputation of being male dominated. Few female role models are present to provide younger women with success stories and encourage women to see a feasible and attractive career path (Ahuja, 2002). Job expectations and conditions such as wages and maternity leave, working hours etc have been found to influence whether women are attracted to education programs related to these job areas (Walsh & Ungson, 2004). Women are known to feel less attracted to the area of IT (together with other engineering areas with high male domination) due to an image of this sector being highly competitive, work is done in isolation and lack of flexibility in relation to family life (Werner et al., 2004).

Over the last decades, many have tried to provide insight to and understanding of why this is so (Ahuja, 2002, Robertson et al., 2001, Du, 2006, Nicolajsen et al., 2007). Generally, it can be said that it is a complex problem including four different layers of actors and issues that all contribute to the problem. The first layer is a personal one representing individuals and individual qualifications, preferences and qualifications. The next two are interpersonal and institutional layers representing issues related to relationships of different kind, local settings, cultures and norms e.g. at universities, in companies etc. presenting the individual to possibilities and barriers for joining and engaging. At the layerl of society more general actors or systems such as the government are at play deciding on national resource allocation and laws this level also include societal values, culture, etc. These different layers are highly interrelated and influencing one another. See for example Du (2006) or Nicolajsen et al (2007) for more details on the different layers and their interrelations.

In 2006, the authors received a grant to study the problem at the Technical University of Denmark (DTU). At that time, the university experienced that less than 2 women would seek uptake on the traditional IT lines while mixed lines were represented with more than half of women. Also, it was experienced that the women already enrolled had a higher chance of dropping out of the study which made it even more frustrating – the university had a clear difficulty in retaining women at the hard core IT lines. Since the university wanted to change the

situation, the authors decided to focus on issues that the university itself would be able to accommodate in order to attract and retain women in the IT lines (Nicolajsen et al, 2007).

The purpose of this paper is to give insight into factors that the university could change in order to retain female students on IT lines. In order to provide such insight, we studied the characteristics of the problem and discussed the issues with students at the university. The paper is therefore organized in the following way: In the next section a number of different perspectives and issues on the problem are presented, the insight is revealed from the literature review conducted. Hereafter we are presenting a case study investigating the phenomenon in a local setting (at the university). Lastly we discuss central issues that seem of importance and finally suggestions are made to improve the situation.

On the lack of women within IT

The problem of attracting and sustaining women within IT is not a new one. Within the last decades the issue has been studied around the world providing and overview of a substantial amount of factors all contributing to the problem. In the following, some of the more general factors are mentioned in order to shed light on the problem. Since it is a complex problem (Du, 2006, Ahuja, 2002, Nicolajsen et al 2007), the different factors have been grouped into more general themes to provide a better understanding and overview.

Female hostile environment

A number of papers address the teaching environments in IT education programs as "female hostile environments". When the teaching is male dominated there is a danger that this may result in a defensive communication culture (Garvin-Doxas & Barker, 2004). Where as the male students adopt this style female students experience a feeling of marginalization. This leads directly into the challenges of a male dominated environment in terms of the physical and social student environment, which provides certain challenges to the female students in their daily life at the university. Pornographic posters and beer bottles in project rooms along with defensive patterns of communication are often conditions female students need to cope with (Du, 2006).

We found evidence in studies related to industry (Adam et al., 2006) as well as universities (Du, 2006), that women in these environments try to hide their female sides by dressing less feminine and accepting male jokes. Adam et al. argue that for women to survive in these areas they need to become one of "them" (i.e. the males) accepting their (male) premises. More studies have found a certain hostility towards women among the women in IT studies (Godfroy-Genin &

Pinault, 2006) or working in the IT industry. The women that survive in the IT area are thus those who can adapt. This might be a reason why some of the women who are part of the IT environment do not see a need for change, as they are actually attracted by this male-dominated world (Hodgkinson, 2000). Others would like to have more women around to make a more women-friendly culture (Du, 2006).

On the other side Faulkner (2000) found evidence that the stereotypes between men and women were more talked about than actually existed, and they may even be seen as vanishing. She found that while women would underplay their technical interest, men would express a distance to human aspects, but in practice there were no real differences. Ahuja (2002) found that whereas there are gender differences in the approach to IT in the elderly generations these are diminishing in the young generations.

Content of the education

According to Faulkner (Faulkner, 2000), there is a hierarchy of values which are highly related to male interests and male views. There is a general understanding that whereas men are interested in technology *per se,* women are more interested in the application of technology and development of technology to solve specific problems. Some argue that this general difference in interest lies in how we play and act in our childhood, where the boys and men are often seen as tinkers dissembling objects into pieces and reassembling the pieces: an activity that women and girls for some reason are less reluctant to engage in. The question is whether this makes women less competent IT engineers. The combination of IT with other domains was found as a way to attract more women (Franscali & McGinnis, 2005).

Teaching and working methods

Quite some studies emphasize that women prefer to cooperate while learning. The lack of collaborative learning is mentioned as a factor limiting the number of female students in IT (Werner et al., 2004). It has also been found that women wish for other types of evaluations of projects and other work (Du, 2006). Evaluation is normally regarding the technical solution and not on e.g. process-related or user-oriented issues. These elements are important in the creation of good solutions and these elements are often argued to be the areas in which women have their interests and strengths. Again the difference in willingness to 'tinker' poses a problem to the female students, especially in the beginning of their engineering studies. This is not prerequisite for the studies however, although it is often needed in much of the course work.

Different initiatives have been made to change the current situation. Preliminary tests and courses for students lacking specific required qualifications

is one way to support the majority of women as well as some men lacking specific qualifications (Boersma et al., 2004). Another suggestion that was found to support the well-being of women was use of more collaboration work as part of the coursework. Especially peer programming, where students sit in pairs was found to support the wellbeing and confidence of all students, however women more than male students (Beerenson et al., 2004; Mbarika et al., 2003). Another positive result of collaboration work was that it supports students in planning their time and delivering their reports (Beerenson et al., 2004).

Role models

In order to attract and retain more women in IT education programs and then later in IT work, role models are often raised as important (Ahuja, 2002). Acording to the literature role models serve quite different purposes. First of all female role models are important to show that it is possible for women to actually survive and function well in this environment, both as students and as teachers, or working within the area with success. Secondly female role models and especially young female role models are important to female students as they signal that a similar person has made it, giving students confidence in their own possibilities to succeed (Lester & Brown, 2004). However it has also been found that male role models with an alternative image to the nerd are of importance. The typical nerd male scares women away (Kjeldskov & Graham, 2003) as they are seen as socially incompetent and limited in their approach to the world.

Preferential treatment

In approaching the problems and trying to reverse the negative cycles of areas of few women it is argued that preferential treatment is not always recommendable and that most women reject it because it leads to negative spotlighting (McLoughlin, 2005). When women receive preferential treatment there is a danger that they are seen as less qualified by themselves, other women and male colleagues (McLoughlin, 2005; Magnusson, 2008). However Egeland (2001) argue that there are needs for preferential treatment. Her argument is that even within academia which is seen as producing objective truth, alliances and networks are important for having your work being accepted and getting access to resources. Her argument is that women might have a hard time to get resources as men are often gatekeepers to resources and they unconsciously favor people and research agendas that resemble themselves and their own work.

We only found one article evaluating an initiative on preferential treatment. In a university setting more women was appointed as teachers, to give the environment a more female orientation, however no increase the number of female students was found (Canes & Rosen, 1995).

Summery

The literature review reveals that male domination may result in a male orientation sometimes difficult for women to cope with and female IT students often use more energy or even need to struggle, as the environment is less natural to them. These women are evaluated on male values moreover some of the women need to make an extra effort in the beginning like taking additional classes to keep up with the men. The review suggests that institutional changes can be made to make it easier for women in IT engineering education if we acknowledge the situation and how it may be differently if we make an effort to change and use resources to provide solutions.

The empirical findings

Our interest in the problem mainly arise from being lecturers within the field of IT at the Technical University of Denmark. However, the challenge is much the same at all universities in Denmark as well as other European and western countries like the US. In order to be able to change this and get more knowledge on the subject, we started a project called "women in IT at DTU" supported by the management at DTU (Technical University of Denmark). The objective of the project was to develop and suggest a strategy highlighting areas where specific activities could be applied in order to attract and retain female students.

Methodology

Our methodological approach was to pinpoint different ways of seeing and approaching the problem meaning revealing a phenomenon. We mainly took an interpretive approach by asking different stakeholders about how they saw problems and solutions. We contacted quite a variety of stakeholders (students, teachers, representatives for industry and working unions), interviewed them and/or invited them to workshops in order to reveal as many different perspectives as possible. We tried to identify initiatives made in industry by contacting working unions. We identified task groups or employees knowledgeable about gender issues, researchers doing research in the field, female teachers at our own and other universities, university administrators, study leaders and in second round students. The different activities in the study can be categorized in three according to the methodologies used.

1. At first we *identified actors and initiatives* regarding the problem of too few women in IT studies to get a feeling about what was going on in the field and what was seen as the problem from different perspectives; our university, other universities, companies, trade unions, governmental bodies etc..

2. At the same time we did a *literature study* of both academic and non-academic material again to reveal different understandings of the problems and solutions.

3. We did a workshop as part of the study. At 7 January 2007 we ran a *Future Workshop for students.* It was highly problematic to recruit female IT students, due to their low number. The few female IT students who accepted our invitation was combined with female students from other lines (with a low representation of women), in addition we invited a couple of male students. In total we had 7 students (2 males). The workshop followed the phases in Jungk and Müllers (1987) Future Workshop concept and was held around the theme: "DTU is experiencing a decreasing uptake to certain lines specifically in respect to the number of females. How can we make DTU a more attractive place to study?". The workshop was held over 2.5 hours and the students were facilitated to go through the basic phases of the Future Workshop: a critique phase, where all participants had the possibility to express their criticisms about being a student at DTU; a fantasy phase, where the students formulated their utopian university and study; and an implementation phase, where the participants discussed their wishes and tried to formulate more realistic suggestions and what it would take to implement them. After each phase the different input was grouped in themes and the more important ones were picked for the continuing phase. We ended the sessions with a broad discussion on the raised issues, including whether these issues were equally important for both male and female students and differences between genders.

Within the existing frame of the study a good source of knowledge would have been interviews with female students who had given up there IT-studies, however we were not allowed access (from the university administration) to this group due to privacy protections.

Field data

Looking at the existing IT education's we already get a hint on what might attract the female students. There is a tendency that the new less traditional IT lines do in fact attract female students. At this university we see an uptake of 27% and 52% of women at the new study lines Medicine and Technology and Design and Innovation. This stand in contrast to the more traditional lines of Communication Technology and Software Technology lines (bachelor lines), as well as the IT diploma line. In 2005, the uptake of women was respectively 0, 1 and 3 females corresponding to a percentage of women of 0%, 2% and 7%. These numbers are quite in line with what is seen in Denmark and the rest of the western world.

Discussions and recommendations from the student workshop

A lot of different issues were discussed at the workshops. The themes identified by the students were teaching methods, image of the university, the social environment, content of the teaching, overview of studies, pre-qualifications etc.

The social student environment

In general the social conditions at university are found to be poor. This was argued in relation to the possibilities at other universities where friends studies. Besides courses there are too few activities and occasions to meet and socialize. The effect is that the students are not engaged enough in the university and there is a lack of university spirit and bonding making the student life less fun. This problem was found intensified due to the location as well as the physical environment. DTU is placed in isolation and the lack of possibilities to eat at campus outside class hours is contributing to a poor social environment. In order to provide for more socializing and university spirit a practical recommendation was that DTU should arrange more activities across the domains such as seminars on making job applications or courses in personal development. There used to be a journal for open debate and discussions among all those at university. Today such a medium is missing. If students should be more active at university and participate more actively in forming a good university, this is seen as a necessary tool.

The size of the campus and the architectural design are physical factors which are seen as important to the social environment. The female students would like to socialize with females from other study lines. However the physical distance between the different buildings and the center of the university are large making it difficult to meet in eg. teaching breaks. More study places and cozy café's are wished for. The buildings are found uninspiring all brown or gray, squared and looking alike. Buildings, data bars and rooms are numbered but still difficult to find. In addition, there is an impression that several buildings are worn and cold during the winter. To make Campus appear more appealing it was suggested to use more colors, funny names for places as well as changes in the outdoor area especially with respect to more outdoor meeting places.

Altogether the appearance and physical environment are found to have a negative impact on the social life, making campus a place where students disappear after classes.

Overview of the study

Being a student is found to be quite confusing sometimes, especially in the beginning of the study. More information to get an overview of requirements and possibilities at the university was requested. The students found in general that it takes about two years before getting an overview of courses available and social arrangements at campus. In addition the administrative personnel were found

unpleasant and not very service minded, making information flow less smoothly. Some of the female students (and male students without a technical high school background) experienced implicit qualifications they could not meet. This resulted in a lack of confident in their qualifications. Part of the problem is the lack of knowledge that others are facing the same problem. If, they would not have felt so stupid and used as much time to consider what to do and question their own abilities.

Teaching content

The students would like a different approach to as well as a change of some of the subjects. Some of the study lines are old fashioned with traditional subject that are found out of date. Efforts has been made to market the lines and courses better; however the students mentioned that it is not enough to change the names of the study lines to make them appear more attractive, if the courses are still the same. Some of the courses seem to be particular "hardcore" which frightens the females away. This is especially a problem when no background and reasons are given for learning these subjects. The female students wish for more interdisciplinary work which could also be linked to projects in industry in order to become more aware of "real" engineering tasks and to practice their engineering abilities. More "female" values are wished for at university to make it easier to be a female student both with respect to content and methods. Many female students experience that they are measured by requirements and attempts to reach male values at university. Broader engineering competencies ought to be accepted and valued at the university including more process oriented qualifications.

Teaching methods

Some of the teachers are using old and outdated material and English as the teaching language lowers the quality of the teaching. In addition the teachers were found incapable of taking critique from the students, making it impossible to get changes without making official complaints. In general the lack of communication between students and teachers seem to be a problem especially for female students, who would like to be able to ask several questions without being regarded as less clever. One of the young males attending was a teaching assistant. He demonstrated well the lack of understanding of women's needs to communicate. He explained that it puzzled him that female students always ask so many questions when they already know. The girls replied that probably they were in need of being confirmed in their way of solving the exercises. Even more severe is the negative spotlighting that some of the female students report; like comments from teachers that girls should pair with boys when programming to get a good result, or teachers always commenting on or asking the one (or the few) female(s) in class. The female students are embarrassed and annoyed hereby.

In relation to the problems just mentioned the students proposed a mandatory program of teacher observation and supervision, making all teachers working with their teaching style. The students also want teacher evaluations to have consequences a suggestion was that students should be able to see teacher/course evaluations for previous years before choosing a course. In addition to changes in communication and teaching styles, some students suggested evaluations of competencies in team work as well as courses or emphasis on methods and techniques for team work as mentioned earlier.

The university image

The lack of women in the university management group is very visible to students as well as outside the university. DTU is thought of as being a kind of dusty place and holds a "nerdy" image. This is further emphasized by the greyish buildings and the systematic numbering of buildings and rooms. The university values being technical prestigious and competitive however the students considered the social and physical frameworks just as important. The students proposed that new types of engineers should be prioritized and shown to society. Role models showing that mathematics and technical science are interesting areas and broad competencies are valued in the engineering world. In general the communication about what an IT engineer is and can do was seen as crucial. A lot of the marketing material shows different sorts of IT or robots but it would be nice with more application oriented material. The students suggested events where engineers represent themselves and show the diversity in the work. Also they would like to have more information of the opportunities working as an IT engineer.

Summary

In summary, the students need more and better opportunities to socialize to support their broader development and wellbeing as human beings and provide for interdisciplinary knowledge to flow. They want more relations to industry to provide a better understanding of the application of their study. Also they would appreciate a higher quality of teaching and teachers using elaborated methods of learning including collaboration and focus on broader engineering competencies. More interaction and more collaboration with students, teachers and industry in an interdisciplinary and international way is what the women want. More information on workshops and a debate meeting held, can be found in Nicolajsen et al (2007).

Discussion and conclusion

The material from the literature study and the results from the workshop are generally in line regarding most of the issues of importance to female students. More collaboration and more communication are important. A focus on process and application and not just solutions and technology per se is another area of importance. An often identified challenge concerns the problem of implicit requirements. Due to the lacking acknowledgement this becomes a private and personal problem, however the university and the teachers are the responsible and this problem must be addressed, revealing when this is a problem and what to do about it in order to create a more supporting student environment.

Within the literature and through interviews held with other stakeholders, there has been an extensive focus on identity and mentors to support the students. However the students themselves were more focused on the possibilities of having a supporting social environment at university supported by a nice physical environment as well as forums to provide for socializing. In addition students expect teachers to engage, inspire and be more supportive. The experience of hostile attitudes to female students is definitely not acceptable and steps must be taking to eliminate such attitudes.

The combinatory study lines being developed currently present a high uptake of female students and may therefore be seen as good examples of how to make IT education programs more popular to women. First of all they provide the combination aspect and a clear profile signaling the application area. Secondly the new lines are built up around new courses and new methods including closer relationship to the industry and new teaching methods such as more projects and more collaboration. This combination is addressing all the issues that are seen as important to female students.

It may be argued that this is not real IT engineers or at least not hard core IT engineers. However the new combinatory educations are producing more women with an IT education who may end up working in the IT sector. More women around will probably help in breaking the evil cycle of a male dominated and orientated environment both in the industry and at university creating a critical mass for women to be more visible, less marginal, having a common voice, which is a way to start changing the environment and working conditions more suitable for women in general.

However these combined educations might also confirm the separation between hardware versus software, programming versus user issues as hence male and female orientation. The question is therefore whether this is good enough. Is there a basic difference in interest or is it possible to get more women to the hard core IT educations? If we look at the combinatory studies part of there success is reshuffling, starting from scratch making a fresh start. The hardcore IT seems to suffer from old traditional educations that seem a bit dusty with old

fashioned courses and a lack of update. This also goes for the teaching methods at least at DTU. There thus seems to be some open possibilities of thinking and approaching these studies a little different. In addition it must be a main issue that negative spotlighting and discriminations are not accepted. Porno and hostile attitudes to women should not be accepted. There is just a need for management to set some rules on accepted behaviors and to help teachers get updated, using more modern teaching methods and providing less traditional content in the study lines.

To us there is no doubt that more women may be recruited and retained if the study environment at universities is more supportive for women. However our research in the field also points to more fundamental roots of the challenge regarding family life, working conditions and our understanding of girls and boys. Our study points at a lot of different interventions that may be made. However doing a lot of single standing inventions may most likely not produce a big effect on its own. At Aalborg University, for example, students have for a long time been working in teams with a problem and process orientation. However this has not attracted more women despite this is some of the wishes from the females (Du, 2006). This may both point to a more fundamental problem of society as already mentioned or the need of a more holistic initiative regarding other issues of importance like a women friendly environment (which have been found lacking at Aalborg University).

Also other institutions have over the last years tried to come up with more creative ideas to attract and sustain females in IT. The IBM, Denmark, has for a long time (since 2002) been running a special "Technology and girls" project. The aim of this project is to make girls, aged 12-15, more interested in IT through workshops and teaching (female IT specialists in pure female classes) (see www-05.ibm,com/dk/info/top for more detail). Others such as the Alexandra Institute (www.alexandra.dk) every year organizes special IT camps for females between 15-18 years – again with the purpose of bringing the girls to understand IT and to create room for them to play around with IT.

There is to us, no doubt that the lack of females in IT only can be changed through a combination of different factors. The initiatives to teach the girls at lower ages more about IT is definitely one step, but also the IT sector itself will have to work on the reputation and actual work situation in IT positions. At universities, many things can be done to attract and retain women in IT lines. However, in order to do that, the traditional hard core environments and teaching styles will have to accommodate more to the female students than today.

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