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Gender differences in computer science: the views of prospective computer engineers

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This study focuses on how prospective computer engineers (PCEs) view gender differences in the field of Computer Science and Engineering (CSE). It is based on research conducted on a sample of 99 PCEs, 43 of which were women. PCEs were asked to express their opinion through the use of a questionnaire addressing the following topics: a) their motivation to select CSE as a subject of study and how this motivation is related to both their primary experience with computers and their family's views regarding CSE as a profession, b) the relation between gender, strengths and weaknesses in CSE as well as cooperation with fellow students of the opposite gender, c) the desirability of having both male and female University Professors in CSE, d) CSE courses and PCE choice, and e) career issues.

Keywords Prospective computer engineers; gender differences; computer science

1.Introduction

Many drastic changes have arisen from the development of Computer Science and Engineering. Our daily life is strongly affected by computers and other gadgets that help us improve our quality of life and computer science will continue to foster the construction of important products as long as new and fresh ideas are developed. The only way to ensure that technology advances positively is to welcome all those prospective computer scientists willing to make a strong effort towards this goal. It is therefore crucial to examine whether both male and female prospective computer professionals feel comfortable and free to study in the formulaic environment in schools of today.

Nowadays, men are more actively involved with computers than women [1-2], although female active involvement in the world of computers dates back to the early 19th century, with many remarkable women making great achievements [3]. Thus, it is crucial to address a significant phenomenon; that women are currently underrepresented in all fields of Computer Science in both undergraduate and graduate studies [1-4], the Computer Science Industry [5] and Computer Science Academia [6-7].

Although there are a great many difficult-to-determine factors that contribute to low participation of women in the field of Computer Science, many studies [8-9-10-7] have been conducted, with very illuminating results. Family is one of the factors that strongly influence children to like or dislike computers: a boy is more likely than a girl to be given a computer game or a PC and to receive support in studying CS or even using computers [11]. Computer games are a very attractive source of fun for boys because of their male-oriented context [5-12]. Consequently, girls who do not enjoy this kind of entertainment [2] are not likely to gain experience with computers in their childhood and subsequently grow up in the

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belief that computers are "a boys' thing" [11]. The lack of experience with computers is an important factor in discouraging girls to decide on taking a Computer Science major [13]. School is another factor that contributes to the formation of a bad relationship between girls and computers. Discrimination within the classroom, as CS teachers rarely interact with female students [2-10], lack of encouragement for girls to study CS [2], limited computer access for girls [9] with boys tending to dominate in computer laboratories [2] are characteristic of schools of today.

Another important factor that causes low female participation in CS is how university policy and departments are formed. The hostile and uncomfortable atmosphere created by boys when they participate in computing activities [2] and the fact that CS Academics interact more with their male students [10] leads to diminished female self-confidence during their CS studies. Moreover, the male-dominated world of Academia (at least in terms of CS Departments) appears to be blocking women from continuing their studies at a doctoral or even postgraduate level [2-10].

As far as the working environment of computer science is concerned, it has also been observed that women have different potential job expectations that conflict with their beliefs of what a Computer Science job entails [5-9]. Additionally, their priorities are quite different from those of men, who are not so greatly concerned about creating a family as they are about their career and professional progress [9-13]. More than this, women accept discrimination about their abilities within their working environment [13]. These are characteristics that women do not appreciate when choosing studies or a career.

The media also contribute to the formation of a CS stereotype [8-9-14]: men more than women are presented using computers [5-10], usually appearing to be myopically focused on their P.C. and lacking in other social interests [14]. In addition, the lack [11-10] of successful women as mentors and role models in the field of CS, at all levels of education, in the CS Industry and in media and society in general, has a negative psychological effect on some women during the course of their studies, often leading them to drop out.

Based on the above, the investigation of conceptions of prospective computer professionals regarding gender differences in CSE is significant. However, such a study has not yet been reported. This paper constitutes our attempt to shed light on the gender issues as viewed by PCEs. In the following section of this paper ,the context of the study reported in this paper is described, followed by the presentation and a discussion of the results emerging from the experiment. Finally, conclusions are drawn.

2. The context of the study

The focus of the survey was to investigate through fifteen (15) suitably chosen questions the conceptions of both female and male PCEs regarding the following issues: a) PCE motivation to select CSE as a subject of study and how this motivation is related to both their primary experience with computers and their family's views regarding CSE as a profession, b) the relation between gender, strengths and weaknesses in CSE as well as cooperation with fellow students of the opposite gender, c) the desirability of having both male and female University Professors in CSE d) CSE courses and PCE choice, e) career. The study was conducted on May 2003, in the Department of Computer Engineering and Informatics, University of Patras, Greece. The questionnaires were given to a sample consisting of 99 students - 43 females, 56 males – all adults. From a methodological point of view, this study was based on phenomenography (Marton, 1988), where student responses rather than their thinking are the focus of study. Student responses were carefully classified in order to depict their perceptions as accurately as possible. The results are presented in the form of comparison between the different female and male opinions.

3. Results and Discussion

a) Table 1 demonstrates PCE motivation to select CSE as a subject of study and how this motivation is related to both their primary experience with computers and their family's views regarding CSE as a profession. As is shown in this Table, male PCEs were equally motivated to select CSE as a subject of study because they find it interesting (51,79%) and because CSE provides greet career opportunities (48,21%). In contrast, the latter motive seemed to motivate most female PCEs (74,42%). It is worth noting that this motive is also acknowledged as the main argument for a positive reaction from PCE families after they have entered CSE School. As for former computer experience, about half of the male PCEs reported that they were sufficiently experienced (44,64%) while about half (41,86%) of the female PCEs reported that they had had no experience at all before entering this School. This lack of experience is probably related to the limited interest in CSE expressed by females.

Table 1. PCEs: motivation to study CS**, family** expectations, former **experience**

Why did you choose CS as a subject of study?				
	BOYS		**GIRLS**	
	NUMBER (N1)	PERCENTAGE (N1/56) %	NUMBER (N2)	PERCENTAGE (N2/43) %
Increased Interest in the Subject	29	51,79	11	25,58
Employment Opportunities/ Prestigious Profession	27	48,21	32	74,42
TOTAL	56	100,00	43	100,00
How did your family and friends react when you started to study CS?				
Positively: Employment Opportunities/ Prestigious Profession	36	64,29	28	65,12
Positively: Personal success	16	28,57	10	23,26
Negatively	4	7,14	5	11,63
TOTAL	56	100,00	43	100,00
Did you have former experience with computers before entering this CS-School?				
None	13	23,21	18	**41,86**
Little	18	32,14	21	48,84
Enough	25	**44,64**	4	9,30
TOTAL	56	100,00	43	100,00

b) Table 2 demonstrates PCEs' answers to questions regarding gender, strengths and weaknesses in CSE, as well as co-operation with fellow students of the opposite gender. As this Table (Table 2i) shows, one out of three female PCEs expressed that they feel inferior in comparison to colleagues of the opposite sex while one out of fourteen male PCEs expressed these feelings. As regards feelings of superiority , an inverse relationship seems to apply. Mixed feelings were primarily reflected by female PCEs. Regarding equality, more boys (51.79%) than girls (34.88%) expressed such feelings. On the whole, the main percentage of boys expressed self-assertion (85. 72%) in contrast to girls, who mainly expressed non self-assertion (55.82%).

As far as gender and co-operation is concerned, a small percentage of PCEs expressed that it is hard for them to collaborate with their classmates of the opposite gender. It is worth noting that there is also a small percentage of PCEs claiming to have no such experience.

Table 2. PCEs: i) gender, **strengths and weaknesses in CSE**, ii) gender and **co-operation**

i) Do you believe that you are superior or inferior in comparison to colleagues of the opposite sex?					**ii) Do you find it hard to cooperate with colleagues of the opposite sex?**				
	BOYS		**GIRLS**			**BOYS**		**GIRLS**	
	Number (N1)	Percentage (N1/56) %	Number (N2)	Percentage (N2/43) %		Number (N1)	Percentage (N1/56) %	Number (N2)	Percentage (N2/43) %
Inferior	4	7,14	14	32,56	Yes	10	17,86	7	16,28
Superior	19	33,93	4	9,30	No	34	60,71	30	69,77
Inf-Sup	4	7,14	10	23,26	No	12	21,43	6	13,95
Equal	29	51,79	15	34,88	experience				
TOTAL	56	100,00	43	100,00	**TOTAL**	56	100,00	43	100,00

c) PCE opinions regarding the desirability of having both male and female University Professors in CSE are reflected in Table 3. More specifically, one out of two girls (Table 3i) seemed to be annoyed by the absence of female University professors while one out of three boys (Table 3ii) expressed that they do not trust female faculty members in CSE. Despite the fact that both genders mainly indicate trust in their university teachers, more girls than boys regard their teachers as having equal skills.

Table 3. PCEs: gender issues and **University Professors**

i) Does the absence of female University Professors bother you?					**ii) Do you trust a female or male University Professor more?**				
	BOYS		**GIRLS**			**BOYS**		**GIRLS**	
	Number (N1)	Percentage (N1/56) %	Number (N2)	Percentage (N2/43) %		Number (N1)	Percentage (N1/56) %	Number (N2)	Percentage (N2/43) %
Yes	10	17,86	20	**46,51**	Man	20	**35,71**	7	**16,28**
No	22	39,29	14	32,56	Woman	3	5,36	2	4,65
Doesn't matter	24	42,86	9	20,93	Equally	33	58,93	34	**79,07**
TOTAL	56	100,00	43	100,00	**TOTAL**	56	100,00	43	100,00

d) Table 4 demonstrates PCE preferences for CSE courses in terms of two main areas: i) hardware/software and ii) theoretical and elected courses. Most PCEs seemed to prefer courses relevant to hardware/software while slightly more girls (27,91%) than boys (19,64%) denoted preference for theoretical and elected courses.

Table 4. PCEs: gender and CSE **courses**

	Which courses do you prefer?			
	BOYS		**GIRLS**	
	NUMBER (N1)	PERCENTAGE (N1/56) %	NUMBER (N2)	PERCENTAGE (N2/43) %
Hardware/Software	45	80,36	31	72,09
Theoretical/Elected	11	19,64	12	27,91
TOTAL	56	100,00	43	100,00

e) A variety of career-plans are reported by PCEs participating in this experiment. In particular, PCEs reported the following career-plans: a) Graduate-postgraduate studies (GPS), b) Related to C.S. work in the Private Sector (RPRS) c) Non-related to C.S.work in the Private Sector (NRPRS), d) Related to C.S. work in the Public Sector (RPLS), e) Non-related to C.S. work in the Public Sector (NRPLS), f) Something else (SE). These plans and the corresponding figures and percentages of PCEs who mentioned them are presented in Table 5i. This Table (Table 5ii) also shows the views of PCEs regarding family issues in relation to a career in CSE.

As it is drawn in Table 5I, approximately one out of two PCEs expressed willingness to undertake Graduate/Postgraduate studies. This is to be expected, as CSE is a rapidly developing field of science. Moreover, a considerable number of girls (30.23%) stated they wished to find work in the Public Sector as this work offers them security. As family is mainly viewed as a female-issue, half the female PCEs were concerned that a CS career would be a deterrent to starting a family. Work in the Public Sector is probably more appropriate for women. In contrast, a considerable number of boys (30.36%) stated their willingness to find work in the Private Sector. In addition, most boys (75%) do not view having a family as a problem in their career. This view, in combination with the self-assertion previously expressed by most of the boys (as shown in Table 2i) is possibly a strong argument for preferring a career in the Private Sector.

Table 5. PCEs: gender, career in CSE and **family** issues

i) What are your plans after completing your studies?					**ii) Do you believe that a career in C.S. would be an obstacle to havng a family?**				
	BOYS		**GIRLS**			**BOYS**		**GIRLS**	
	Number (N1)	Percentage (N1/56) %	Number (N2)	Percentage (N2/43) %		Number (N1)	Percentage (N1/56) %	Number (N2)	Percentage (N2/43) %

GPS	31	55,36	24	55,81	Yes	14	25,00	24	55,81
RPRS	17	30,36	8	18,60	No	42	75,00	19	44,19
NRPRS	5	8,93	0	0,00	**TOTAL**	56	100,00	43	100,00
RPLS	4	7,14	13	30,23					
NRPLS	0	0,00	2	4,65					
SE	4	7,14	2	4,65					

5. Conclusions

The views of Prospective Computer Engineers regarding gender issues in CSE are presented in this paper. The issues addressed are: a) PCE motivation to select CSE as a subject of study and how this motivation is related to both their primary experience with computers and their families' views regarding CSE as a profession, b) the relation between gender, strengths and weaknesses in CSE, as well as co-operation with fellow students of the opposite gender, c) the desirability of having both male and female University Professors in CSE d) CSE courses and PCE choice, and e) career. The analysis of the data shows that: a) males are equally motivated to select CSE as a subject of study in terms of their interest in this subject and because CSE provides great career opportunities, while females are mainly attracted by CSE-job security. This may be because a considerable percentage of men claimed that they had had prior experience with computers before entering University, while an equal number of women claimed that they had not. The families of PCEs acknowledge their children's career opportunities through acquiring a CSE degree, CSE being a prestigious profession and also acknowledge that entering a CSE department is a measure of their children's personal success. It is worth noting that PCE family views regarding CSE are also reflected as main motives for their children to select CSE as a subject of study, b) most men expressed self-assertion (equal and superior feelings) in comparison to colleagues of the opposite sex, while most females expressed the opposite. In particular, one out of three male PCEs feels superior to women in CSE while the same percentage of women feel inferior. Most PCEs appreciate co-operation with colleagues of the opposite gender while the percentages of PCEs who find this work hard or do not have such experience are small, c) one out of three men do not trust women as University Professors in CSE while half of the female PCEs feel uncomfortable with the absence of female faculty members, d) most PCEs prefer hardware and software courses, while slightly more female PCEs seem to prefer theoretical and elected courses and e) half of the PCEs acknowledge that they would like to continue their studies at postgraduate level. However, it appeared that one out of three male PCEs would prefer a job in Industry while the same percentage of female PCEs expressed that they would prefer a job in the Public Sector.

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