THEMES IN SCIENCE AND TECHNOLOGY EDUCATION
Volume 1, Number 2, 2008, Pages 179-194

Computer Science and Engineering Students Addressing Critical Issues Regarding Gender Differences in Computing: a Case Study

Evrikleia Tsagala and Maria Kordaki
tsagala@ceid.upatras.gr, kordaki@cti.gr
Department of Computer Engineering and Informatics, University of Patras, Greece

Abstract

This study focuses on how Computer Science and Engineering Students (CSESs) of both genders address certain critical issues for gender differences in the field of Computer Science and Engineering (CSE). This case study is based on research conducted on a sample of 99 Greek CSESs, 43 of which were women. More specifically, these students were asked to respond to a specially designed questionnaire addressing the following issues: a) essential motives in selecting CSE as a subject of study, their primary experience with computers and their family's views regarding CSE as a career prospect, b) the relationship between gender, strengths and weaknesses in CSE and 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 CSESs choice, and e) career issues. The analysis of the data shows that: a) gender inequality in CSE still exists at tertiary level, b) there is a number of students of both genders who feel interest and self confident in CSE, they believe in equality in competence of both genders in CSE and have dreams of a job with prospects as computer professionals, c) interest, self confidence in CSE are closely related to previous experience with computers and to the encouragement by family and school to learn about computers, and d) the general atmosphere and policy in CSE Departments play an essential role for women-students to feel as equals to their male counterparts.

Introduction

Nowadays, men are more actively involved with computers than women, although female active involvement in the world of computers dates back to the early 19th century, with many remarkable women making great achievements (Galpin, 2002; Gürer & Camp, 2002; Gürer, 1995; Lopez et al., 2005). It is therefore crucial to address a significant current phenomenon; that women are at present underrepresented in all fields of Computer Science (CS), in both undergraduate and graduate studies (Galpin, 2002; Wardle & Burton, 2002; Stockard et al., 2005), the Computer Science Industry (Duplantis et al., 2002) and Computer Science Academia (Camp, 1997; Moskal, 2002). Given this fact, it is important to investigate the different factors affecting motivation in studying CSE among males and females.

Although it is difficult to determine the variety of factors that contribute to the low participation of women in Computing, many studies have been conducted, with very illuminating results (Fisher & Margolis, 2002; Moskal, 2002; Garvin-Doxas & Barker, 2004; Othman & Latin, 2006). Family is one of the factors that strongly influence children in their liking or disliking 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 (Balcita et al., 2002; Tsagala & Kordaki, 2005). Computer games are a very attractive source of fun for boys because of their male-oriented context (Duplantis et al., 2002; Kiesler et al., 2002; Pearl et al., 1990). Consequently, girls who do not enjoy this kind of entertainment are not likely to gain experience with computers in their childhood and subsequently grow up in the belief that computers are "a boys' thing" (Gürer & Camp, 2002; Balcita et al., 2002). With this in mind, it is important to investigate both the primary informal experience with computers gained by male and female students in CSE departments and their families' views on CSE as a prospective profession for their sons and daughters.

School is another factor that contributes to a good/bad relationship developing between girls and computers. A supportive school environment can encourage girls to lower their anxiety with computers and to be involved and joyful with them (Olivieri, 2005). Despite this, discrimination within the classroom (with CS teachers rarely interacting with female students), lack of encouragement for girls to study CS and limited computer access for girls (with boys tending to dominate in computer laboratories) are characteristic of schools today (Lazowska, 2002; Jepson & Perl, 2002). Thus, investigating the opinions of students in CSE departments regarding the role of secondary school in their experience with computers becomes significant.

Another important factor that causes low female participation in CS is how the policies adopted by departments and universities are formulated (Meeden et al., 2003; Frieze et al., 2006). The hostile and uncomfortable atmosphere created by boys when they participate in computing activities and the fact that CS Academics interact more with their male students, leads to diminishing female self-confidence during their CS studies (Gürer & Camp, 2002; Lazowska, 2002). 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. In addition, the dearth of successful women as mentors and role models in the field of CS, at all levels of education, in the CS Industry, the media and society in general, has a negative psychological effect on some women during the course of their studies (Balcita et al., 2002; Lazowska, 2002). It is therefore essential to investigate how University students in CSE departments deal with their colleagues of the opposite gender in terms of equality/inequality and collaboration as well as their strengths and weaknesses in CSE studies. Moreover, it is of interest to examine if students in CSE departments are bothered by the absence/presence of female University Professors and whether these students equally trust male and female University professors.

As far as the Computer Science working environment 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 (Duplantis et al., 2002; Jepson & Perl, 2002). Additionally, their priorities are quite different from those of men, who are not so greatly concerned about creating a family as they are about developing their career and making professional progress (Jepson & Perl, 2002; Teague, 2002). Therefore, it is important to investigate gender differences in the career plans of students in CSE departments.

With the above in mind, it is critical to examine the different perspectives of prospective computer professionals, both male and female, regarding issues widely acknowledged as significant in the formation of gender inequality in CSE. In this paper, the issues in focus are related to gender differentiation and: a) motivation to study CS, previous experience with computers and family perceptions of a CSE-oriented job, b) strengths and weaknesses in CSE studies, including cooperation with students of the opposite gender, c) most favored courses in CSE and most trusted Professors, and d) career plans in CSE. This study investigates the views of CSESs of both genders with respect to the afore-mentioned critical issues.

Despite the fact that, a considerable amount of research has been conducted into the main de-motivators for women to study CSE, a study investigating the views expressed by both genders on all the above-mentioned issues as well as the main mo-

tives and the general positive factors that encourage women to study CSE and to plan a related career has not yet been reported. In the following section, the context of the study reported in this paper is described, followed by the presentation and discussion of the results emerging from the experiment. Finally, conclusions are drawn.

The context of the study

The focus of this study was to elicit the opinions of CSE students in five general areas of possible gender differences: these five areas are investigated with twelve (12) questions, with respect to the issues described in the previous section. These areas with the corresponding questions are presented below:

- CSESs motivation in selecting CSE as a subject of study, their primary experience with computers and their family's views regarding CSE as a profession. The questions posed were: a) why did you choose this School? b) How did your family react when you began to study Computer Science? c) Did you have any former experience before entering this School? and d) What did Secondary School offer you as far as computers is concerned?
- The relation between gender, strengths and weaknesses in CSE as well as cooperation with fellow students of the opposite gender. The questions posed were: a) Do you believe that you are superior or inferior in competence regarding CSE studies in comparison to colleagues of the opposite sex? b) How do colleagues of the opposite sex treat you? and c) Do you find it hard to cooperate with colleagues of the opposite sex?
- The desirability of having both male and female University Professors in CSE. The questions posed were: a) Does the absence/presence of female University Professors bother you? and b) Who do you trust more - a female or male University Professor?
- CSE courses and CSESs choice. The question posed was: a) Which courses do you prefer?
- Career. The questions posed were: a) What are your plans after completing your studies? and b) Do you believe that making a career in CSE would be an obstacle to creating a family?

It is worth noting that, there were no available responses for the students to select regarding with the questions posed. Students were free to write their own responses to these questions. The study was conducted in May 2003, in the Department of Computer Engineering and Informatics, University of Patras, Greece. The question-

naires were given to a sample of 99 adult students (43 females, 56 males), aged 19-23 years old. The total student-population in this Department was about 800 students 25% of them were females. This study can be characterized as a case study (Cohen & Manion, 1989) as this was performed in only one Computer Science and Engineering Department. 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. In fact, the students' responses were classified in terms of the topics emerged. The results are presented in the form of comparison between the different female and male opinions. To check the statistical significance of these differences, tests of significance were also carried out. In particular, these results were also analyzed by using chi-square test of independence. The significance level a=0.05 was also corrected using the Bonferroni correction by dividing it with the number of questions (0.05/12=0.004).

Results

In this section, the issues addressed in the previously mentioned questionnaire are presented together with the results of the study and our interpretations of them.

CSESs motivation in selecting CSE as a subject of study, their primary experience with computers and their family's views regarding CSE as a profession

The answers provided by the CSESs to the relevant questions are presented in Table 1. As is shown in this Table, male CSESs were equally motivated in selecting CSE as a subject of study because they find it interesting (51.8%) and because CSE provides great career opportunities (48.2%). In contrast, the latter motive, i.e. great career opportunities, seemed to motivate significantly more females (74.4%) than males $\chi2(1, n = 99) = 6.94, p < .05$. It is worth noting that this motive is also acknowledged as the main argument for a positive reaction from CSES's families after they have entered a CSE School. It is also important to note that the majority of these students expressed that their admission in a CSE School was welcome by their families. As for former computer experience, significantly more males (44.6%) than females (9.3%), $\chi2(2, n = 99) = 14.79, p < .05$, reported that they were sufficiently experienced. In addition, significantly more females (41.9%) than males students (23.2 %) reported that they had had no experience at all before entering this CSE School $\chi2(2, n = 99) = 14.79, p < .05$. In total, three out of four male students (76.8%) reported some pri-

mary experience with computers in comparison with three out of five female students (58.1%). The percentage of female students who expressed a limited interest in CSE is also related to the low percentage of them who expressed little or no previous experience with computers. Regarding the role of Secondary School, it is worth noting that a considerable number of students expressed some kind of reinforcement by their schools (41.9% for women and 44.7% for men).

Table 1. CSESs: motivation to study CSE, family expectations, former experience and the role of the secondary school

Statements	Males		Females	
	Number (n1)	Percentage (n1/56) %	Number (n2)	Percentage (n2/43) %
Why did you choose CSE as a subject of study?				
Increased Interest in the Subject	29	51.8	11	25.6
Employment Opportunities/Prestigious Profession	27	48.2	32	74.4
TOTAL	56	100.0	43	100.0
How did your family react when you began to study CSE?				
Positively: Employment Opportunities/ Prestigious Profession	36	64.3	28	65.1
Positively: Personal success	16	28.6	10	23.3
Negatively	4	7.1	5	11.6
TOTAL	56	100.0	43	100.0
Did you have any previous computer experience before entering this CSE-School?				
None	13	23.2	18	41.9
Little	18	32.2	21	48.8
Enough	25	44.6	4	9.3
TOTAL	56	100.0	43	100.0
What did secondary school offer you in terms of computers?				
Encouraged me to use computers	9	16.1	9	20.9
Discouraged me	13	23.2	17	39.5
Gave me knowledge	16	28.6	9	21.0
No course in school	18	32.1	8	18.6
TOTAL	56	100.0	43	100.0

However, a remarkable percentage of female students (39.5%) reported being discouraged by their teachers, who suggested CSE might not be a suitable study subject for girls. In addition, a notable percentage of male students expressed that they hadn't received any tuition in computer-based courses in their schools. Finally, it is worth noting that all students who reported an interest in CSE also reported previous experience with computers, encouragement by their school-teachers to study CSE and acceptance of their tertiary-education choice by their families.

Gender, strengths and weaknesses in CSE and cooperation with fellow students of the opposite gender

CSES's answers to the specific questions posed are depicted in Table 2.

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

Statements	Males		Females	
	Number (n1)	Percentage (n1/56) %	Number (n2)	Percentage (n2/43) %
a) Do you believe that you are superior or inferior in competence regarding CSE studies in comparison to colleagues of the opposite sex?				
Inferior	4	7.2	14	32.6
Superior	19	33.9	4	9.3
Inf-Sup	4	7.1	10	23.2
Equal	29	51.8	15	34.9
TOTAL	56	100.0	43	100.0
b) How do colleagues of the opposite sex treat you?				
Equally	52	92.9	29	67.4
Not equally	4	7.1	14	32.6
TOTAL	56	100.0	43	100.00
c) Do you find it hard to cooperate with colleagues of the opposite sex?				
Yes	10	17.9	7	16.3
No	34	60.7	30	69.8
No experience	12	21.4	6	13.9
TOTAL	56	100.0	43	100.0

As is shown by the above Table (Table 2, a), the majority of CSESs expressed self-confidence regarding their competence in CSE (92.8% males and 67.4% females). However, one in three female students expressed that they feel inferior in comparison to colleagues of the opposite sex while only one in fourteen male students seemed to share such feelings. As regards feelings of superiority, an inverse relationship seems to apply. Mixed feelings were primarily reflected by female students. Regarding feelings of equality, more males (51.8%) than females (34.9%) expressed such feelings. In addition, significantly more males than women expressed superiority feelings (33.9 % males and 9.3% females), in contrast to the inferiority feelings expressed mainly by females (32.6% females and 7.2% males), $\chi 2(3, n = 99) = 21.02$, $p < .05$.

A remarkable percentage of CSESs reported that they feel they are treated as equals by their colleagues of the opposite gender (92.9% males and 67.4% females) However, significantly more females (32.6%) than males (7.1%), $\chi 2(1, n = 99) = 10.56$, $p < .05$, expressed that they feel they are not equally treated (Table 2, b). As far as gender and co-operation is concerned (Table 2, c), a remarkable percentage of these students (more than 60.7%) expressed that it is not hard for them to collaborate with their classmates of the opposite gender. However, a low percentage of CSESs reported no experience with classmates of the opposite gender.

c) Gender differences and the desirability of having both male and female CSE University Professors

CSESs opinions to the related issues are reflected in Table 3. As is shown in Table 3a, significantly more females (46.5%) than males (17.9 %), $\chi^2(2, n = 99) = 10.40$, $p < .05$ seemed to be annoyed by the absence of female University professors while one in three males (Table 3 b) expressed their lack of trust in female CSE faculty members.

Here, it is worth mentioning that in the said CSE Department, only three female adjunct assistant professors exist. Despite the fact that the majority of both genders indicate trust in their university teachers, more females than males regard their teachers as having equal skills. It is worth noting that these male students also expressed feelings of superiority in their competence in field of CSE regarding their female colleagues.

Table 3. CSESs: gender issues and university professors

a) Does the absence of female University Professors bother you?				
	Males		**Females**	
	Number (n1)	**Percentage (n1/56) %**	**Number (n2)**	**Percentage (n2/43) %**
Yes	10	17.9	20	46.5
No	22	39.3	14	32.6
Doesn't matter	24	42.8	9	20.9
TOTAL	56	100.0	43	100.0
b) Who do you trust more – a female or male University Professor?				
	Males		**Females**	
	Number (n1)	**Percentage (n1/56) %**	**Number (n2)**	**Percentage (n2/43) %**
Male	20	35.7	7	16.3
Female	3	5.4	2	4.6
Equally	33	58.9	34	79.1
TOTAL	56	100.0	43	100.0

CSE courses and CSESs choices

Table 4 demonstrates CSESs preferences for CSE courses in terms of two main areas: i) hardware/software. Some of the reported examples of hardware courses were: Computer architecture, VLSI Design, Embedded Systems Design. Some of the reported examples of software courses were: Programming in C, Software Engineering, Data Bases, Operational Systems and Data Structures, and ii) theoretical courses such as: Discrete Mathematics, Theory of Computation, Theoretical Data Bases, Theory of Algorithms etc.

As is shown in Table 4, most students seemed to prefer courses relevant to hardware/software while slightly more females (27.9%) than males (19.6%), [$\chi^2(1, n = 99) = 0.93, p > .05$] denoted preference for theoretical courses. It is worth to note that, these latter students also reported lack of any experience with computers prior to their entering this CSE School.

Table 4. CSESs: gender and CSE courses

Which courses do you prefer?				
	Males		Females	
	Number (n1)	Percentage (n1/56) %	Number (n2)	Percentage (n2/43) %
Hardware/Software	45	80.4	31	72.1
Theoretical	11	19.6	12	27.9
TOTAL	56	100.0	43	100.00

CSESs and career

Table 5. CSESs: gender, career plans in CSE and family issues

a) What are your plans after completing your studies?				
	Males		Females	
	Number (n1)	Percentage (n1/56) %	Number (n2)	Percentage (n2/43) %
GPS	31	55.4	24	55.8
RPRS	17	30.4	8	18.6
NRPRS	5	8.9	0	0.00
RPLS	4	7.1	13	30.2
NRPLS	0	0.00	2	4.6
O	4	7.1	2	4.6
b) Do you believe that a career in CSE would be an obstacle to having a family?				
	Males		Females	
	Number (n1)	Percentage (n1/56) %	Number (n2)	Percentage (n2/43) %
Yes	14	25.0	24	55.8
No	42	75.0	19	44.2
TOTAL	56	100.0	43	100.0

A variety of career-plans are reported by CSESs participating in this experiment. In particular, these students reported the following main career-plans: a) Graduate-Postgraduate Studies (GPS), b) CSE-related work in the Private Sector (RPRS) c) Non-CS-related work in the Private Sector (NRPRS), d) CSE-related work in the Public Sec-

tor (RPLS), e) Non-CSE-related work in the Public Sector (NRPLS), f) Other (O). These main plans and the corresponding percentages of CSESs who mentioned them are presented in Table 5 (a). This Table (Table 5, b) also shows the views of CSESs regarding family issues in relation to a career in CSE. As can be seen in Table 5a, approximately one in two students expressed their willingness to undertake Graduate/ Postgraduate studies. This comes as no surprise, since CSE is a rapidly developing field of science. Moreover, significantly more females (30.2%) than males (7.1%), $\chi^2(1, n = 99) = 9.12$, $p < .05$, stated they wished to take up employment in the Public Sector, as they believe this would provide them with security. As having a family is mainly viewed as a female-issue, half the female students were concerned that a CSE career would be a deterrent to starting up a family and that work in the Public Sector is probably more suitable to that end. In contrast, a considerable number of males (30.4%) stated their willingness to work in the Private Sector. In addition, the view that having a family would be an obstacle to career prospects is shared by significantly more females (55.8%) than males (25.0%), $\chi^2(1, n = 99) = 9.77$, $p < .05$. This view, combined with the feelings of self-confidence and superiority previously expressed by most of the males (see Table 2, a), is possibly a strong argument for preferring a career in the Private Sector.

Discussion

The views of Computer Science and Engineering students of both genders regarding essential issues about gender differences in CSE were presented in this paper. These issues are: a) students' motivation to select CSE as a subject of study, students' primary experience with computers as well as 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 sex, c) CSESs and the desirability of having both male and female University Professors in CSE department, d) CSE courses and students' choice, and e) CSESs career plans.

a) *CSES's motivation to select CSE as a subject of study, CSESs' primary experience with computers as well as their families' views regarding CSE as a profession.* The analysis of the data shows that 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 is probably due to the fact that a considerable percentage of male students reported that they had had experience with computers prior to their entering University, while an equal number of women reported that they had not (Balcita et al., 2002). Secondary education seemed to play a positive but

rather insignificant role in students' previous experience and knowledge of computers. However, in the case of female students, their secondary school experience discouraged a considerable amount of them from studying CSE as their teachers suggested CSE might be 'not suitable for females' (Lazowska, 2002; Jepson & Perl, 2002). The families of CSESs 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 to note that, these students' family views are reflected as main motives for both their sons and daughters to select CSE as a subject of study. It is also worth noting that, all CSESs who expressed an interest/non interest in CSE had had/not had previous informal - not school based - experience with computers, encouragement/discouragement by their school teachers and supporting/not supporting family views to their choice to study CSE.

b) *The relation between gender, strengths and weaknesses in CSE, as well as co-operation with fellow students of the opposite sex.* In general, the majority of CSESs reported self-confidence about CSE. However, more males expressed superior feelings in comparison to colleagues of the opposite sex, while most females expressed the opposite (Gürer & Camp, 2002). In particular, one in three male students feel superior to women in CSE while the same percentage of women feels inferior. Moreover, the majority of students expressed that they feel they are treated equally by their colleagues of the opposite gender. Despite this fact, a considerable percentage of females expressed the opposite feeling (Lazowska, 2002). In addition, a considerable percentage of students did not appreciate co-operation with colleagues of the opposite gender. Bearing this in mind, we can say that the relationships between CSESs of different genders in this particular CSE department are guarded, segregated and derogatory to women.

c) *CSESs and the desirability of having both male and female University Professors in CSE departments.* The majority of these students expressed trust to their University professors of both genders. However, one in three men reported that they do not trust women as University Professors in CSE; that is to say that these students view this Science as a male-oriented field (Balcita et al., 2002), with the implication that these students believe that female professors are not as competent as the male professors in CSE. Half of the female students also expressed that they feel uncomfortable with the absence of female faculty members. In our view, this means that female students need to communicate better with female university professors in terms of receiving support, attention and mentoring in

their studies and career. In addition, female students probably need to see living examples of successful women in the field of CSE, to inspire them to progress in their studies and to express their capabilities more forcefully.

d) *CSE courses and CSESs choice.* Most CSESs prefer hardware and software courses, while slightly more female students seem to prefer theoretical courses. This may be attributed to the lack of previous PC experience on the part of female students.

e) *CSESs career plans*. Half of these students acknowledge that they would like to continue their studies at postgraduate level. However, it appeared that one in three male students would prefer a job in Industry while the same percentage of female students expressed that they would prefer the security of a job in the Public Sector. These different job expectations are probably caused by the reported differentiations in self-confidence regarding Computing and to the fact that men are not so greatly concerned as women about creating a family (Teague, 2002; Jepson and Perl, 2002).

The above findings would appear to point to three main gendered profiles for the CSESs participating in this experiment:

i) The '*self-confident'* computer professional profile, including individuals of both genders and emphasizing: interest in CSE, strong self-confidence in the field, hardware/software-oriented interests, trust in (and desire for) both men and women as competitive professors and colleagues in CSE, dreams for employment opportunities in CSE and for a job with prospects.

ii) The *'superior'* computer professional profile, mainly male-oriented and emphasizing: interest in CSE, feelings of superiority in the field, hardware/software-oriented interests, dreams for a competitive and profitable job in Industry, lack of faith in women as competitive professors and colleagues in CSE.

iii) The '*inferior'* computer professional profile, mainly female-oriented and emphasizing: low interest in CSE, feelings of inferiority in the field, theoretically-oriented interests, dreams of job security within the Public Sector, worry over the absence of women as professors and lack of trust in men as colleagues in CSE.

CSESs with profiles (i) and (ii) reported previous experience with computers, and reinforcement from their family and school to enter a CSE School.

It is worth to note that, the motivators for boys and de-motivators for girls regarding Computing -which emerged from this study - are in confirmation with the correspondent motivators/de-motivators reported in the literature. However, the positive mo-

tivators and behaviours of females CSESs that emerged from this study contribute to the extension of the reported findings. On the whole, the investigation of the kind of positive behaviour of female CSESs about these issues regarding CSE and the kind of positive influences these students expressed have not yet been reported in the literature.

Conclusions

Critical issues of gender differences in Computer Science and Engineering were addressed in this paper by Computer Science and Engineering students in tertiary education. In particular, the analysis of the data showed that interest in the field of CSE and the employment opportunities that a CSE-oriented job entails are the main motivators for CSESs of both genders. These motivators were mainly expressed by the majority of male students while the latter was reported as the main motivator for females. Job-oriented motivators are mainly encouraged by the opinions of family members regarding CSE as a profession. Self confidence and competitiveness in the field of CSE has been also expressed by the majority of CSESs. Interest, self confidence and competitiveness in the field of CSE seemed to be closely related to previous experience with computers and to the encouragement by family and school to learn about computers and to study CSE. More male students than females reported such experience before entering this CSE School.

It is worth to note that, despite the fact that there is a considerable percentage of male students who feel superior to women and a remarkable percentage of women students who demonstrate feelings of inferiority, there is a category of students, including students of both genders, who demonstrate interest and self-confidence in the field of CSE. These students believe in equality in competence of both genders in CSE and have dreams of a job with prospects as computer professionals. These students reported previous experience with computers as well as reinforcement by their schools and families to enter a CSE School.

On the whole, our study supported that equality of gender in CSE is encouraged/discouraged by: a) the experience/inexperience of students with computers acquired privately or at secondary schools before entering CSE schools, b) the encouraging/discouraging role of family and of secondary school CS teachers, c) the presence/absence of female university professors, d) the friendly/hostile atmosphere created by males in CSE departments, as well as e) the support/non support policy of CSE departments with respect to female students and software/hardware courses.

Despite the limitations of this study, due to the fact that this was performed only in one country (Greece) and in one University department, we conclude with a brief note on its implication to taking appropriate actions to decrease gender inequality in CSE in future. Based on the analysis of the CSESs views we can claim that gender equality in CSE can be supported by: a) designing software artefacts and games taking into account the variety of differences of both genders, b) educating parents about CS as a suitable career for both; their daughters and sons, c) educating secondary level education CS-teachers to effectively deal with gender inequality in CSE, d) providing a gender centred CSE education at the tertiary level and e) providing a sufficient number of women as CS role models in both secondary and tertiary level of education.

Acknowledgements

Many thanks to Dr Basilis Gialamas for his help in the statistical analysis and to both Eleni Thermogianni and Petros Mikos for helping in the collection of the data used in this study.

References

Balcita, A., Carver, D. and Soffa, M.L. (2002). Shortchanging the Future of Information Technology: The Untapped Resource. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 32-35

Camp, T. (1997). The Incredible Shrinking Pipeline. *Communications of the ACM*, 40(10), 103-110

Cohen, L. & Manion, L. (1989). *Research Methods in Education*. London: Routledge.

Duplantis, W., MacGregor, E., Klawe, M. and Ng, M. (2002), `Virtual Family`: An Approach to Introducing Java Programming. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 40-43

Fisher, A. & Margolis, J. (2002). Unlocking The Clubhouse: The Carnegie Mellon Experience. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 79-83

Frieze, C., Hazzan, O., Blum, L. & Dias, M.B. (2006). Culture and Environment as Determinants of Women's participation in Computing: Revealing the Women-CS Fit". In Proceedings of the 37th *SIGSE technical symposium on Computer Science Education, SIGCSE '06, 38(1)*, 22-26, Houston, Texas, USA

Galpin, V. (2002). Women in Computing Around the World. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 94-100

Garvin-Doxas, K. & Barker, L. J. (2004). Communication in Computer Science Classrooms: Understanding Defensive Climates as a Means of Creating Supportive Behaviors. *ACM Journal on Educational Resourses in Computing*, 4(1), 1-18

Gürer, D. & Camp, T. (2002). An ACM-W Literature Review on Women in Computing. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 121-127

Gürer, D. (1995), Pioneering Women in Computer Science. *Communications of the ACM*, 38(1), 45-54

Jepson, A. & Perl, T. (2002). Priming the Pipeline. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 36-39

Kiesler, S., Sproull, L. & Eccles, J. (1985). Pool Halls, Chips, and War Games: Women in the Culture of Computing. *Psychology of Women Quarterly*, Vol. 9, 451-462

Klawe, M. (2002). Girls, Boys, and Computers. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 16-17

Lazowska, E. (2002). Pale and Male: 19th Century Design in a 21st Century World. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 11-12

Lopez, A.M., Schulte, L.J. and Giguette, M.S. (2005). Climbing Oto the Shoulders of Giants. In Proceedings of the 36th *SIGSE technical symposium on Computer Science Education, SIGCSE '05,* 37(1), 401-405, St. Louis, Missouri, USA

Marton, F. (1988). Phenomenography: Exploring Different Conceptions of Reality. In D.M. Fetterman (Eds). *Qualitative Approaches to Evaluation in Education: The Silent Scientific Revolution*, (pp. 176-205). New York: Praeger

Meeden, L., Newhall, T., Blank, D. & Kumar, D. (2003). Using Departmental Surveys to Assess Computing Culture: Quantifying Gender Differences in the Classroom. In Proceedings of *ITiCSE '*03, 35(3), 188-192, June, 30 - July 2, Thessaloniki, Greece, 2003

Moskal, B. (2002). Female Computer Science Doctorates: What Does the Survey of Earned Doctorates Reveal? ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 105-111

Olivieri, L.M. (2005). High School Environments and Girl's Interest in Computer Science. ACM *SIGSE Bulletin Inroads,* 37(2), 85-88

Othman, M. & Latih, R. (2006). Women in Computer Science: no shortage here!. *Communications of the ACM*, 49(3), 111-114

Pearl, A., Pollack, M., Riskin, E., Thomas, B., Wolf, E. & Wu, A. (1990). Becoming a Computer Scientist.*Communications of the ACM*, 33(11), 47-57

Stockard, D., Klassen, M. & Akbari, A. (2005). Computer Science Education Pipeline. *Journal of Computing Sciences in Colleges*, 20(3), 102-113

Teague, J. (2000). Women in Computing: What brings them to it, what keeps them in it? *GATES*, 5(1), 45-49

Tsagala, E. & Kordaki, M. (2005). Essential Factors that Affect Students' Choices to Study Computer Science: Gender Differences. *7th International Conference for Computer Based Learning in Science*, Zilina, Slovakia, 541-552

Wardle, C. and Burton, L. (2002). Programmatic Efforts Encouraging Women to Enter the Information Technology Workforce. ACM *SIGSE Bulletin Inroads, Special Issue: Women and Computing*, 34(2), 27-31