Undergraduate Studies in Computer Science and Engineering: Gender Issues

Aristidis Ilias and Maria Kordaki

Department of Computer Engineering and Informatics,
University of Patras,
26500, Rion Patras, Greece
<aristeid@ceid.upatras.gr>, <kordaki@cti.gr>

Abstract

This study focuses on gender issues in terms of participation, achievement and duration of studies at the Tertiary level of education in Computer Science and Engineering (CS&E). For this reason, 1957 degrees earned by Computer Engineers were studied. These diplomas cover a 21 year period of graduation at the Computer Engineering and Informatics Department (CEID), University of Patras, Greece. The analysis of the data shows that: a) male graduate students outnumbered the female ones by three to one, b) in terms of achievement, no significant differences exist between male and female graduate computer engineers, and c) female students complete their studies earlier than their male counterparts.

Keywords: Gender, Computer Science and Engineering, Achievement, Tertiary Education

1.Introduction

Nowadays, not only are more men than women actively involved with computers but many believe that it is more natural for men to study Computer Science (CS) than for women [6] [7]. In fact, women are underrepresented in all fields of Computer Science: undergraduate and graduate studies [6], [16], [19], CS Industry [4] and CS Academic field [2]. Female participation in CS is between 10% and 40% in most countries and courses, with a wide spread in this range [6]. Thus, it is crucial to address the important underlying issue: Should so few women studying or working in computing be a cause for concern?

Moreover, a number of studies have demonstrated that women are usually treated as not being suited to using computers: a) discrimination, within the classroom, as CS teachers rarely interact with female students [7], [14], within the family, for example by placing the family PC in the boy's room [1] and within the working environment [17], [18], b) lack of encouragement in school [7] and at home [3] in using computers, as they usually viewed as "not suitable for girls", c) limited access to computers or computer games in both schools [3], [10], as boys tend to dominate in computer laboratories [7], and video arcades [12], d) the hostile and uncomfortable atmosphere usually created by boys when they participate in computing activities [7].The media also contribute to the formation of a CS stereotype [5], [10], [13]: more men than women are presented using computers [4], [11], [14], usually appearing to be myopically focused on their PC and lacking in other social interests [13].

On the other hand, it is well known that, active involvement by women in the world of computers dates from the early 19th century, where more women than men were occupied with these machines because of their experience in typing and telephony [15]. In addition, there are many pioneering women who have contributed significantly to computer science through their great achievements [8]. Despite this, female Computer Scientists have been - and sometimes still are - treated in the main as inferior scientists when they cooperate with their male counterparts: 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 [7], [14].

With the above in mind, it is also crucial to address an underlying question: Wonder rarely the success of some women in CS&E? Subsequently, it is clearly important to determine if achievement and the duration of studies in CS&E are affected by gender differentiation. Despite the fact that many researchers have focused on the specific reasons that cause women's low participation in CS, surveys investigating the relationship between gender, achievement and the duration of studies in CS&E have not yet been reported.

The aim of this article is to investigate the nature of the relationship between gender and studies in CS&E in terms of participation, achievement and duration.

The article is organised as follows: "The Context of the Study" presents the research methodology in detail;

"The Results" gives a full description of the upcoming results of the research, illustrated with pertinent diagrams, and the "Discussion" section discusses the findings within the theoretical framework. Overall conclusions of the article are summarized in the "Conclusion" section.

2.The Context of the Study

This study focuses on the relation between gender differences, participation, achievement and duration of studies in CS&E. This is an updated and expanded study of a previous one that was conducted in the CEID, University of Patras, Greece [9]. One thousand ninety hundred and fifty seven (1957) degrees earned by graduate students of the previously mentioned department were studied in terms of gender and: a) degrees earned, b) achievement in terms of grading, and c) duration of studies in CEID. The sample of diplomas used regarded all graduated students of CEID, from June 1985 since April 2005 (21 years in total).

3.Results

a) Gender and diplomas regarding CS&E taken at CEID

The number of graduates per year during the last 21 years at CEID is presented in Table 1 (Column 2). This Table also shows the number of female and male students graduated during these years (Column 3 and Column 4, correspondingly). The percentages of female/male graduates per year are also presented in Column 5 and Column 6, correspondingly. The last column of Table 1 shows the ratio of female/male graduate students per year. The penultimate row of this Table demonstrates the total number of students who graduated during the last 21 years of CEID and the total number of female and male graduates as. The last row of Table 1 presents the average of students of genders, the average of female and male graduates as well as the average percentage of female and male graduates and the average ratio of female/male graduates.

As is shown in Table 1, the average of graduate students during the last 21 years at CEID is 93.19 graduates per year. The average of female graduate students during these years is 21.24 while the average of male graduate students is 71.95. Consequently, during this 21-year period, the average ratio of male/female graduate students is 0.3, signifying that male students are about 3 times the number of female ones.

Table 1. Gender and graduation during a 21- year period in CEID

Year of Graduation	Number of Graduates			Percentage of Graduates		Female/Male
	Students	Female	Male	Female (%)	Male (%)	
1985	31	11	20	35.48	64.52	0.55
1986	40	13	27	32.50	67.50	0.48
1987	42	8	34	19.05	80.95	0.24
1988	73	16	57	21.92	78.08	0.28
1989	131	34	97	25.95	74.05	0.35
1990	118	29	89	24.58	75.42	0.33
1991	101	31	70	30.69	69.31	0.44
1992	84	18	66	21.43	78.57	0.27
1993	119	26	93	21.85	78.15	0.28
1994	105	19	86	18.10	81.90	0.22
1995	101	24	77	23.76	76.24	0.31
1996	108	21	87	19.44	80.56	0.24
1997	120	30	90	25.00	75.00	0.33
1998	99	17	82	17.17	82.83	0.21
1999	101	19	82	18.81	81.19	0.23
2000	76	20	56	26.32	73.68	0.36
2001	106	28	78	26.42	73.58	0.36
2002	114	26	88	22.81	77.19	0.30
2003	129	21	108	16.28	83.72	0.19
2004	130	30	100	23.08	76.92	0.30
2005	29	5	24	17.24	82.76	0.21
Total	1957	446	1511			
Average	93.19	21.24	71.95	22.79	77.21	0.30

b) Gender and achievement at CEID

Average achievement. The average achievement of graduates per year, based on their degree grade, is presented in Table 2. In particular, the average achievement of female graduates per year is presented in Column 2 and Column 5. In addition, the average achievement of male graduates per year is presented in Column 3 and Column 6.

Elements of Tables 1 and 2 also appeared in [9] where a first approach of this study was attempted.

Table 2. Gender and achievement

Year of Graduation	Average achievement		Year of Graduation	Average achievement	
	Female	Male		Female	Male
1985	7.56	7.70	1996	7.90	8.04
1986	7.51	7.37	1997	7.82	8.09
1987	7.66	7.64	1998	7.91	7.94
1988	7.57	7.76	1999	7.99	7.93
1989	7.89	7.92	2000	7.92	7.96
1990	7.92	8.16	2001	7.74	7.80
1991	8.17	8.04	2002	7.62	7.66
1992	8.13	8.23	2003	7.87	7.71
1993	8.07	7.97	2004	7.47	7.54
1994	8.01	8.03	2005	7.50	7.38
1995	8.06	8.08			
Average				**7.85**	**7.89**

In terms of achievement, as shown in Table 2, no significant differences exist between graduates of opposite gender during the 21-year period of graduations at CEID.

Classification of graduates in terms of their degree grades. Table 3 presents a classification of graduates in terms of their degree grades. This classification is used by all Universities in Greece. The total number of graduates included in each category is presented in Column 5 of this Table while the numbers of female and male graduates included in these categories are presented in Column 3 and Column 4 correspondingly. In Column 6 and Column 7 the percentages of female and male graduates in each category are also demonstrated.

As is shown in Table 3, the percentage of degrees earned by females and classified as "very good" (25.19) is higher than that of the average degree earned by females (22.9, see Table 1) while the percentage of degrees earned by females classified as "excellent" (16.67) is less than this average. In contrast, the percentages of degrees earned by males classified as "excellent" and "good" are more than that of the average degree earned by males (77.21, see Table 1). This means that female graduates are more binding and stable in the "very good" category while their male counterparts are more balanced among different categories of degrees.

Table 3. Gender and classification of graduates in terms of their degree grades

Achievement	Degree	Number of students (n)		Total Students (s)	Percentage (n/s) (%)	
		Female	Male		Female	Male
Excellent	8.5- 10.00	62	310	372	16.67	83.33
Very Good	7.5- 8.49	262	778	1040	25.19	74.81
	6.5- 7.49	121	404	525	23.05	76.95
Good	5.5- 6.49	1	19	20	5.00	95.00
Total		**446**	**1511**	**1957**		

Table 4 presents a classification of graduates of the same gender based on their degree grades. The criteria used for this classification are the same as with those previously mentioned. The number of female graduates included in each category is presented in Column 3 while the number of male graduates classified in each category is also presented in Column 5 of this Table. Corresponding percentages are demonstrated in Column 4 and Column 6 of this Table. In Table 4 one can see that, in the "excellent" category, the percentage of male graduates (20.52%) is higher than the percentage of female graduates (13.90%). The percentage of female graduates characterized as "very good" is higher (85.87%) than the percentage of male graduates in this category (78.23%). On the whole, no significant gender differences were found to exist regarding achievement.

Table 4. Gender and classification of graduates of the same gender in terms of their degree grades

Achievement	Degree	Female		Male	
		Number (n)	Percentage (%)	Number	Percentage (%)
Excellent	8.5- 10.00	62	13.90	310	20.52
Very Good	7.5- 8.49	262	58.75	778	51.48
	6.5- 7.49	121	27.13	404	26.74
Good	5.5- 6.49	1	0.22	19	1.26
Total		446	100	1511	100

Gender of the first five graduates, in terms of their degree grades. In the positions of first and second graduate, including 21 graduates for each position, there were 2 women (9.5%) and 19 men (90.5%). In third and fifth place, among 21 graduates for each position, there were 4 women (19.05%) and 17 men (80.95%). In fourth place, among 21 graduates, there are 5 women (23.8%) and 16 men (76.2%). It is worth noting that the percentage of women achieving first and second place in their class is lower than the average of female graduates per year (22.9) while the percentage of women achieving third to fifth place is very close to this average.

4.Discussion

Gender and diplomas in CS&E at CEID. It is well documented in the literature that women are under-represented in both computers in general and studies in CS&E [6], [7]. The general idea that women are under-represented in CS&E is also supported by the data

c) Gender and the duration of undergraduate studies at CEID

The average of duration of undergraduate studies regarding the students graduated during 21 years of graduation at CEID is as follows: 5.92 years for female and 6.14 years for male students. It is worth noting that in Greek Universities there are three graduation times per year. This means that the average of duration of female graduate studies is about four months less than the corresponding average of their male colleagues.

graduate student, during the 21-year graduation at CEID, there were 2 women (9.5%) and 19 men (90.5%). In the position of third and fifth graduate student during this period of time there were 4 women (19.05%) and 17 men (80.95%). In the fourth position there were 5 women (23.8%) and 16 men (76.2%). It is worth noting that the percentage of women achieving first and second place in their class is lower than the average of female graduates (22.9), while the percentage of women achieving third to fifth place is very close to this average.

Gender and duration of undergraduate studies at CEID. The average duration of undergraduate studies of female students at CEID is less than the duration of the corresponding studies of male students (about four months).

5.Conclusions and Future Research
Gender differences, participation, achievement and the duration of studies regarding CS&E have been investigated in this study. In particular, 1957 diplomas of graduate Computer Engineers from the CEID, University of Patras, Greece were studied. The analysis of the data showed that women are under-represented in this department. More specifically, the analysis of the data demonstrated that during 21 years of graduation at CEID male graduates outnumbered the female ones. Regarding achievement, no significant differences exist between male and female graduate computer engineers. However, female students complete their studies earlier than their male counterparts.

More research is needed to investigate if a specific gendered profile for Computer Engineers can be formed taking into account both different preferences by gender regarding the variety of subjects included in CS&E as well as different strengths and weaknesses by gender related to these subjects.

References
[1] Balcita, A., Carver, D. and Soffa, M.L., 2002. Shortchanging the Future of Information Technology: The Untapped Resource. *In Women and Computing*, 34(2), 32-35.

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

[3] Countryman, J., Feldman, A., Kekelis, A. and Spertus, E., 2002. Developing a Hardware and Programming Curriculum for Middle School Girls. *In Women and Computing*, 34(2), 44-47.

[4] Duplantis, W., MacGregor, E., Klawe, M. and Ng, M., 2002. `Virtual Family`: An Approach to Introducing Java Programming. *In Women and Computing*, 34(2), 40-43.

[5] Fisher, A. and Margolis, J., 2002. Unlocking The Clubhouse: The Carnegie Mellon Experience. *In Women and Computing*, 34(2), 79-83.

[6] Galpin, V., 2002. Women in Computing Around the World. *In Women and Computing*, 34(2), 94-100.

[7] Gürer, D. and Camp, T., 2002. An ACM-W Literature Review on Women in Computing. *In Women and Computing*, 34(2), 121-127.

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

[9] Ilias, A. and Kordaki, M. (2005). Gender Differences and Achievement in Computer Science and Engineering. In Proceedings of IADIS *International Conference Cognition and Exploratory Learning in Digital* Age (CELDA 2005) (pp. 543-544), Porto, Portugal, 14 -16 December 2005.

[10] Jepson, A. and Perl, T., 2002. Priming the Pipeline. *In Women and Computing*, 34(2), 36-39.

[11] Johnson, D. and Miller, K., 2002. Is Diversity in Computing a Moral Matter? *In Women and Computing*, 34(2), 9-10.

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

[13] Klawe, M., 2002. Girls, Boys, and Computers. *In Women and Computing*, 34(2), 16-17.

[14] Lazowska, E., 2002. Pale and Male: 19th Century Design in a 21st Century World. *In Women and Computing*, 34(2), 11-12.

[15] Lee, J., 2002. Well Behaved Women Rarely Make History! *In Women and Computing*, 34(2), 14-15.

[16] Moskal, B., 2002. Female Computer Science Doctorates: What Does the Survey of Earned Doctorates Reveal? *In Women and Computing*, 34(2), 105-111.

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

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

[19] Wardle, C. and Burton, L., 2002. Programmatic Efforts Encouraging Women to Enter the Information Technology Workforce. *In Women and Computing*, 34(2), 27-31.