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Course Selection in Computer Science: Gender Differences

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Abstract

This study focuses on the investigation of the course choices made by undergraduates of different gender in Computer Science (CS). For this purpose, the degrees of all graduates (89 graduates) from the CS and Technology Department at University of Peloponnese, Tripoli, Greece, since its establishment were studied. The analysis of the data shows that: (a) the percentage of female graduates is lower than the percentage of male graduates, (b) higher percentage of girls choose courses that belong to the 'Theoretical CS' division, (c) higher percentage of boys choose courses that belong to the 'Software Systems' division, (d) girls seemed to not prefer programming 'lab-based' courses, (e) girls and boys chose equally courses from the 'Computer Technology and Computer Systems' division, but some of these courses are not selected by any of the girls, (f) more girls than boys choose 'General Education' courses, and (g) higher percentage of girls choose courses related to humanities and social sciences.

Keywords: Computer Science, Course Choices, Gender

1. Introduction

Women are underrepresented in all fields of Computer Science: undergraduate and graduate studies, the Computing Industry and the Computing Academic Sector (Camp, 2002; Hill et al, 2010). The ratio of women to men involved in Computing shrinks dramatically from early student years to working years. This phenomenon, known as 'the pipeline shrinkage problem' is complex and multi-faced, but well known and documented (Gürer & Camp, 2002; Ladner & VanDeGrift, 2011). Studies over the past two decades have shown that there are numerous factors contributing to the fact that women have a lower participation rate in CS than men (Gürer & Camp, 2002). Despite the fact that many remarkable women have made their mark in the history of CS through their great achievements (Gürer, 2002), female computer scientists are treated as inferior when they cooperate with their male counterparts, not to mention that many believe that is more natural for men than women to study computing. It is stated that girls lose interest in CS early on, as they don't gain as much experience with computers as boys do during their childhood and at school (Margolis & Fisher, 2002). Back to their early years, the male orientation of computer

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games seems to be a crucial factor in discouraging females to decide on taking a Computing major (Denner et al, 2012), and the fact that often times boys tend to monopolize instructors' time, leaving the girls to try and figure things out on their own, can frustrate young girls. Moreover, more boys are positive and more girls are negative towards computers. Women tend to avoid CS because of the 'tinkering' aspect of the field, in spite of being attracted to the mathematical and logical aspects of computing. Even though they perform at the same levels, women have less confidence in their abilities and individual accomplishments than men (Sax et al, 2010), and report feeling 'out of place' in the male-dominated, hacker culture. The most harmful factors causing this low self-confidence are the discrimination both within the classroom and within the family, the limited access to computers both at school and at home and the hostile and uncomfortable environment created by boys when participating in computing activities (Gürer & Camp, 2002). Media has a strong influence on girls' impression of CS, forming a computing stereotype where men, more than women, are represented using computing for hours and lacking in other social interests. As far as the world of Academia is concerned, in terms of Computing Departments, it is a male-dominated, so non-women-friendly environment. Women are not encouraged to pursuit a doctoral or at least continue their studies at a postgraduate level. This lack of women in the field of research has a negative psychological effect on some women during their studies (Cheryan et al, 2011). Despite these obstacles, girls are willing to participate in CS as long as they feel that their involvement is meaningful and relates to social contribution (Cohoon, 2001). They prefer to apply the knowledge they acquire in order to produce something useful (Counryman et al, 2002). Bearing the above in mind, it is important to investigate the course choices of students of both genders in CS. Despite the fact that many researchers have focused on the specific reasons that cause low female participation in Computing, surveys on the gender differences in course choices in CS have not yet been reported.

The article is organised as follows: Section 2 presents details about the manner in which the research was conducted, referring to the study sample and the methodology followed. Section 3 gives a full description of the research findings. Finally, overall conclusions are summarized in Section 4.

2. The context of the study

This study focuses on the investigation of gender differences in course choices in CS. For this reason, 89 degrees that cover a 6-year period of graduation at the Department of Computer Science and Technology, University of Peloponnese, Greece were studied. In fact, the contains the degrees of all graduate students who enrolled from 2002 to 2008. In particular, 77 non core courses were studied. Students had to choose some of these 77 courses that belonged to 4 divisions: 'Theoretical Computer Science' (11 courses), 'Computer Technology and Computer Systems' (16 courses), 'General Education Courses' (21 courses) and 'Software Systems' (29 courses). This categorization is common among CS Departments in Greek Universities. This study can be characterized as a case study (*Cohen & Manion*, 1994).

3. Results

The number of graduates, the last 6 years, is 89. The number of male graduates is 69 (N1=69) (77,53%) and the number of female graduates is 20 (N2=20) (22,47%). This section gives a description of the research findings. The Tables that are presented here, are organized as follows: courses (first column), number of boys (b) who choose that course (second column), the percentage of the boys (b/N1, third column), the percentage of the girls (g) who choose that course (fourth column) and the percentage of the girls (g/N2, fifth column). All Tables are divided in two parts: in the first part there are the courses that are chosen by a higher percentage of boys than girls, in the second part vice versa. Bold numbers are used when the difference of the percentages between boys and girls is higher than 13%, or the percentage is zero.

3.1 Students' Choices of 'Theoretical Computer Science' Courses

In Table 1 one can see that, the courses that are chosen by a higher percentage of female than by male students are: 'Computational Complexity', 'Computational Science II', 'Advanced Topics in Theoretical CS, 'Fractals', 'Parallel Algorithms', 'Computational Geometry', 'Cryptography. This means that 7out of the 11 Theoretical CS' Courses are chosen more by female students, and just 4 courses, are chosen more by male students. What is more, 'Parallel

Algorithms', 'Computational Geometry' and 'Cryptography' are chosen by a higher percentage of female students (at least 13% higher than the percentages of boys).

Table 1: Students' Choices of 'Theoretical Computer Science' Courses

Courses	Number of Boys (b)	Percentage of boys (b/N1)	Number of Girls (g)	Percentage of girls (g/N2)
Advanced Topics in Theoretical CS	16	**23,19%**	2	**10%**
Operational Research	10	14,49%	1	5%
Graph Theory	11	15,94%	2	10%
Combinatorial Optimization	63	91,30%	18	90%
Computational Complexity	17	24,64%	5	25%
Computational Science II	34	49,28%	10	50%
Advanced Topics in Theoretical CS	0	0%	1	5%
Fractals	19	27,54%	7	35%
Parallel Algorithms	53	**76,81%**	18	**90%**
Computational Geometry	25	**36,23%**	12	**60%**
Cryptography	10	**14,49%**	8	**40%**

3.2 Students' Choices of 'Computer Technology and Computer Systems' Courses

Table 2: Students' Choices of 'Computer Technology and Computer Systems' Courses

Courses	Number of Boys b	Percentage of boys b/N1	Number of Girls g	Percentage of girls g/N2
Computer organization	**63**	**91,3%**	**14**	**70%**
Advanced Computer Network Issues	8	11,59%	0	**0%**
Introduction to embedded systems	14	20,29%	2	10%
Robotics	4	5,8%	0	**0%**
Computer Communications and Networks II	7	10,14%	1	5%
Synthesis of Digital Architectures	2	2,9%	0	**0**
Digital Signal Processing	1	1,45%	0	**0%**
Computer arithmetic	1	1,45%	0	**0%**
Introduction to Hardware Description Languages	38	55,07%	11	55%
Digital signal processing	2	2,9%	1	5%
Computer Architecture II	1	1,45%	1	5%
Digital circuit design	21	30,43%	7	35%
Wireless and Mobile Communications	1	1,45%	2	10%
Advanced Computer Architectures	16	23,19%	7	35%
Information theory and coding	**17**	**24,64%**	**8**	**40%**
Hardware description languages II	**19**	**14,49%**	**6**	**30%**

As shown in Table 2, 9 out of the 16 'Computer Technology and Computer Systems' courses are chosen by more male than female students and 7 courses are chosen by more female than male students. In particular, 'Information theory and coding' and 'Hardware description languages II' are chosen by a higher percentage of girls (at least 13% higher than the percentages of boys). It is worth noting that 5 courses of this division were not chosen at all by girls.

3.3 Students' Choices of 'Software Systems' Courses

Table 3 presents the choices of male and female students regarding the courses of the 'Software Systems' division. As shown in Table 3, female students choose only 8 courses out of the 29 of this division at a higher percentage than male students. In addition, 'C Lab', 'Advanced User Interfaces, Virtual Reality', 'Java Lab', 'Software Engineering', 'Distributed Systems', 'Information Systems' are chosen by a higher percentage of boys (at least 13% higher than the correspondent percentages of girls). It is worth noting that very few girls (or none) choose 'lab-based courses', like 'C Lab', 'Java Lab' και 'C++ Lab' (5%, 0%, 5%).

Table 3: Students' Choices of 'Software Systems' Courses

Courses	Number of Boys (b)	Percentage of boys (p/N1)	Number of Girls (g)	Percentage of girls (g/N2)
C Lab	**23**	**33,33%**	**1**	**5%**
Advanced User Interfaces, Virtual Reality	**43**	**62,32%**	**7**	**35%**
Java Lab	**13**	**18,84%**	**0**	**0%**
Software Engineering	**16**	**18,84%**	**1**	**5%**
Distributed Systems	**16**	**23,19%**	**1**	**5%**
Information Systems	**34**	**49,28%**	**7**	**35%**
Intelligent systems and applications	29	42,03%	6	30%
Compilers II	34	49,28%	8	40%
C++ Lab	9	13,04%	1	5%
Multimedia Technology	33	47,83%	8	40%
Artificial Intelligence	57	82,61%	15	75%
Special topics in software systems	5	7,25%	0	**0%**
Advanced topics in Soft. Systems	29	42,03%	7	35%
Information management on the Internet	22	31,88%	5	25%
Database Management Systems	18	26,09%	4	20%
Parallel programming	59	85,51%	16	80%
Current Software Systems	14	20,29%	3	15%
Advanced topics in Programming	7	10,14%	1	5%
Theories of Progr. Languages & Compilers	12	17,39%	3	15%
Advanced Topics in Database	5	7,25%	1	5%
Data management systems	35	50,72%	10	50%
Data and information Visualization	2	2,9%	1	5%
System Analysis	36	52,17%	11	55%
Data and information Visualization	8	11,59%	3	15%
Information Retrieval	2	2,9%	2	10%
Intelligent Systems and Applications	3	4,35%	3	15%
Databases II	6	8,7%	4	20%
Systems security	**12**	**17,39%**	**6**	**30%**
Techniques in machine learning & data mining	**15**	**21,74%**	**9**	**45%**

3.4 Choices of 'General Education Courses'

Table 4: Students' Choices of 'General Education' Courses

Courses	Number of Boys (b)	Percentage of boys (b/N1)	Number of Girls (g)	Percentage of girls (g/N2)
Introduction to the economic science I	8	11,59%	0	0%
English	64	92,75%	16	80%
Legal issues in informatics	7	10,14%	1	5%
New product and service development	6	8,7%	1	5%
French	4	5,8%	1	5%
Game theory	4	5,80%	1	5%
French Terminology	10	14,49%	3	15%
Computers and Education	19	27,54%	6	30%
Informatics Teaching	14	20,29%	5	25%
Differential Equation	29	42,03%	9	45%
Introduction to the Economic Science II	0	0%	1	5%
Philosophy	10	14,49%	4	20%
English Terminology	65	94,2%	20	100%
History of Computers and Communications	51	73,91%	16	80%
Social and Professional Issues	13	18,84%	5	25%
Advanced Topics in Information & Data Management	5	7,25%	4	20%
Cognitive Science	**8**	**11,59%**	**5**	**25%**
Banking IT	**8**	**11,59%**	**5**	**25%**
Psychology	**24**	**34,76%**	**11**	**55%**
Pedagogics	**47**	**68,12%**	**18**	**90%**
Management Information Systems	**9**	**13,04%**	**7**	**35%**
Sociology	**19**	**27,54%**	**10**	

Table 4 presents the choices of male and female students regarding the 'General Education' courses. As shown in Table 4, female students choose 16 courses out of the 22 of this division at a higher percentage than male students. As it is also shown in Table 4, 'Cognitive science', 'Banking IT', 'Psychology', 'Pedagogics', 'Management Information Systems', 'Sociology' are chosen by a higher percentage of girls (at least 13% higher than the percentages of boys).

1. Conclusions

Gender differences and course choice in CS have been investigated in this study. For this reason, the degrees (89 degrees), earned by the students -during a 6-year period of graduation at the Department of CS and Technology, University of Peloponnese, Greece- were studied. The analysis of the data showed that: (a) the percentage of female graduates is lower than the percentage of male graduates, (b) higher percentage of girls chose courses that belong to the 'Theoretical CS' division, (c) higher percentage of boys chose courses that belong to the 'Software Systems' division, (d) higher percentage of girls seemed to not choose programming, and 'lab-based' courses, (e) girls and boys chose equally courses from the 'Computer Technology and Computer Systems' division, but some of these courses were not selected by any of the girls, (f) more girls than boys chose 'General Education' courses, and (g) higher percentage of girls chose courses related to humanities and social sciences. However, the findings of this study cannot be generalized, as the data refer only to one university department of a particular country. For this reason, similar studies should be carried out in other CS departments. Furthermore, more research is needed in order to study these data in relation to other characteristics of the sample, for instance, course performance.

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