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Article

Gender Gap in Computer Science: Preferences and Performance

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Abstract: The aim of the present study is to investigate both the performance and preferences of males and females Computer Science (CS) graduates. In order to attain the above goal, a quantitative case study was conducted regarding 89 degrees, acquired from 2006 to 2012, from the Department of Computer Science and Technology, University of Peloponnese, Greece. The analysis of the data revealed that in terms of performance, no significant differences between the mean grades of males and females exist, in almost most of the courses included in the curriculum of the aforementioned CS department. Any statistically significant differences in performances were present in almost equal number of courses in favor of males and females. It seems also, that females performed better in the courses they selected more than males. Regarding preferences, in CS courses, it seems that gender differences are existent. Males preferred more than females did core programming courses and advanced topics of Software Systems, computer networks, computer engineering, robotics and mathematics, whereas females preferred more the study of algorithms and security issues, computer fractals, data management, computer architecture, and mobile communication. In addition, females preferred courses in reference with humanities and social sciences, CS terminology, and career opportunities. Yet, females did not select any of programming lab-based courses, computer engineering, computer network issues and robotics.

Keywords: Computer Science; Tertiary Education; Course Selection; Performance; Gender Gap

1. Introduction

Women are underrepresented in most of the Science, Technology, Engineering and Math (STEM) fields as well as in Computer Science (CS) (Cohoon and Aspray 2006; Hill et al. 2010; Camp 2012; Ascraft et al. 2012). Actually, CS remains an especially heavily male-dominated field, even after several years of extensive efforts to promote female participation (Camp 2012). The ratio of women to men

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involved in CS shrinks dramatically from early student years to working years. In fact, women are underrepresented in all fields of CS education; teaching staff in secondary education (Kordaki and Berdousis 2015), undergraduate and graduate studies (Kordaki and Berdousis 2017) as well as in the academic sector (Camp 2002; Hill et al. 2010; Berdousis and Kordaki 2016). This phenomenon, acknowledged as 'the pipeline shrinkage problem' is complex and multi-faced, but well known and documented (Gürer and Camp 2002; Ascraft et al. 2012). Over time, research has identified several key social and structural factors affecting women's participation in CS, often deterring them from choosing future education or careers in CS, revealing that the reasons for such low participation are multilayered (Gürer and Camp 2002; Margolis and Fisher 2003; Cohoon and Aspray 2006; Barker and Aspray 2006; Ascraft et al. 2012). First, Gürer and Camp (2002) defined 14 such factors, while a later review from Ascraft et al. 2012 revealed that females' perceptions, interest, confidence and attitudes towards CS are shaped by the larger environment they learn about CT including: computing experience, support, stereotypes, and education. In that sense, girls lose interest in CS early on, as they don't gain as much experience with computers as boys do (Margolis and Fisher 2003), while the kind of the computing experience seems to be a crucial factor (Barker and Aspray 2006). What is more, parents and family members have significant influence as role models with the types of messages or beliefs they communicate to girls both implicitly and explicitly (Ashcraft et al. 2012), which in some cases, maybe unintentionally, can be obstacles for the female members (Gürer and Camp 2002). Most recent studies argue that one novel and powerful social factor that may perpetuate the underrepresentation of women in CS is the stereotypes about the culture of the field, which in some cases act as 'educational gatekeepers', discouraging females from entering CS (Cheryan et al. 2009; Cheryan et al. 2015). In some cases, students have stereotypes about the culture of CS and girls face negative stereotypes about their abilities, making them feel like they do not belong in CS. Key factors that discourage females' participation in CS, contributing to the loss of interest of females, are connected to the education as well, and especially, the CS curriculum, the teaching practices and the uncomfortable for females learning environments (Ashcraft et al. 2012).

However, can gender gap in CS be attributed to differences in performance and in CS course preferences? Such questions have been addressed in other disciplines in STEM education but still remain unanswered in CS. As supported in the literature review, actual gender differences in cognitive skills and academic ability are non-existent. However, individuals still believe in and behave in response to the belief of such gender differences (Alkhadrawi 2015). As a result, a large gender disparity persists in higher education and careers in the STEM fields in which male participation and success in these fields exceeds that of females (Alkhadrawi 2015). Actually, any gender differences are neither biological nor cognitive but they are socially constructed 'myths' that constitute obstacles that hinder female success. These myths are not real in the scientific and empirical sense regarding actual measures of ability and intelligence, but they are real because they have real social implications.

In fact, evidence in the STEM field indicate that it seems to be no significant differences in performance between males and females, with males to perform slightly better on the construct of science and have more self-efficacy (Hyde et al. 1990; Jacobs et al. 2002; Ding 2006; Kiran and Sungur 2012). The fact that the gender gap in measures of STEM ability and achievements has narrowed and nearly disappeared has been mentioned since '90 (Mickelson 1989; Adelman 1991; Meece and Courtney 1992). The ability and intelligence of males and females in science subjects showed little to no difference (Mickelson 1989) while, especially in math performance gender differences were small, and in some cases females outperformed males, but only by a negligible amount (Hyde et al. 1990).

Later studies emphasized on the performance of males and females in STEM in high school, and specifically, on the tools that school uses to measure science achievements: grades and test scores. The results regarding the gender differences between grades and test scores are interesting. While males and females are similar in achievement, females have higher final grades in STEM while males have higher test scores (Saunders et al. 2004; Britner 2008; Santrock 2008). Britner (2008) found that females in life science class earned higher grades than boys, while Saunders et al. (2004) found that females' math final grades were significantly higher than males. By contrast, in most cases males perform better on science tests (Ormrod 2007). Nevertheless, there is evidence supporting that females perform as

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well as males in academic achievement, including science (Mickelson 1989; O'Reilly and McNamara 2007), and actually, female and male students do not differ significantly on the objective examination of achievement in science knowledge (Freedman 2002). Nevertheless, in a review of 25 years of evidence, Jacobs (2005) argued that differences in grades is generally weak and concluded that females have achieved increasing success in STEM courses, closing the gender gap, while a later study showed that no significant gender differences were found on five science academic outcomes (Matthews et al. 2009).

Actually, research suggests that the domain-specific self-competence beliefs and domain-specific motivation and performance is the key to the performance, as those students who believe that they have the ability to accomplish a particular task perform better and are more motivated to select increasingly challenging tasks (Jacobs et al. 2002). Thus, when different domains are taken into consideration, females perform better than males on the social aspects of science factors and males tend to perform better than females on the constructs of science factors (Kiran and Sungur 2012). Another study in high school supports that, gender gaps in the percentage of graduates earning credits in specific STEM courses vary by course (Laird et al 2009). A larger percentage of female than male graduates earned credits in biology, chemistry, and health science/technology, while, on the other hand a larger percentage of males than females earned credits in physics, engineering, engineering/science technologies, and CS (Laird et al. 2009). Likewise, a most recent study supported that, a higher percentage of male than female high school graduates expressed interest in mathematics, and the same was true for interest in science (Cunningham et al. 2015). Nevertheless, Van de Gaer et al. (2008) contended that gender differences in math participation and in math achievement can be shifted over time. At their study they noticed that, while at first males scored significantly higher than females, the gap eventually closed and females surpassed males at higher grade levels. In that sense, it seems that interventions in the curriculum in order to adapt it to the interests of females, promoting their abilities (Haussler and Hoffmann 2002), as well as providing extracurricular and informal learning experiences, such as participation in science competitions or science-related field trips (Cunningham 2007) can endorse females' science performance and interest.

Despite the fact that, it seems that there is no significant difference in the performance of males and females in STEM courses, a closer examination of the course selections reveals certain persistent differences in preferences regarding STEM. Even if some evidence suggests that males and females do not differ significantly in the numbers in STEM courses, and that the gap between females and males in the actual number of mathematics and science courses taken, appear to be diminishing (Alkhadrawi 2015), yet, gender differences remained in the kinds of courses chosen. Studies over the past years revealed that gender gaps persist in terms of enrollment in specific courses and majors. Even when the overall number of males and females in science majors is nearly equal, the specific field within science still differs significantly: males take high-level mathematics, engineering, CS, and physical sciences in higher numbers, while more females take biology and chemistry (Kenway and Gough 1998; Bussey and Bandura 1999; Coley, 2001; Amelink 2009). According to the Amelink (2009) males are more likely to major in mathematics and quantitatively oriented sciences. On the other hand, research data argue that in high school, females actually take biology and chemistry more than males do (Amelink 2009). It seems that males attach a higher value and utility to math and have higher self-concept in math, reasoning why they choose to participate more in math than females (Van de Gaer et al. 2008). Evidence from college reveals differences in the preferences as well. Marion (1993) argued that nearly as many females as males took science and math courses, while male students enrolled in the more mathematically and quantitatively demanding STEM courses. In addition to choices made in courses and majors, choices made for activities outside of school also appear to differ. Some evidence suggests that females were less likely than males to participate in science activities outside the classes (Amelink, 2009). This lower level of participation may affect science interests and future participation in science fields. The differences in course preferences are reflected in career choices as well. Upon closer inspection within the science and math fields, differences emerge in terms of which field within STEM, males and females pursue in their education and careers (Amelink, 2009).

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Despite the relevant research in STEM fields, a study investigating gender differences within CS in terms of performance and course preferences in higher education has not been reported. In this sense, the research questions of the current research are the following:

1. What are the differences between males' and females' course preferences in CS tertiary education, and
2. What is the performance of males and females in courses of CS departments

This study could contribute to the field of CS curriculum and instruction by determining to what extent more effort is needed in the education system to dispel gender myths and remove perceived boundaries within certain CS career paths. Subsequently, this study could lead to the incorporation of teaching strategies to challenge persistent myths -about gender differences in CS performance- and perceived obstacles about gender and CS.

The paper is organized as follows: Next, the context of the study is presented and then, the results of the data analysis. A substantiated discussion and interpretation of the research findings is followed, and conclusions are drawn. Finally, the limitations of the study and future research dimensions are identified.

2. Context of the study

This study focuses on the investigation of: (a) the gender differences in course preferences in CS, and (b) the relationship between gender and performance in CS courses. For this reason, 89 degrees covering a 6-year period of graduation at the Department of Computer Science and Technology (DCS&T), University of Peloponnese, Greece, were studied. In fact, this study has taken into consideration the degrees of all graduate students who enrolled from 2002 to 2008. The number of male graduates was 69 (N1=69; percentage 77,53%) and the number of female graduates was 20 (N2=20; percentage 22,47%). These data are in-line with a relevant research about a representative typical percentage of CS graduates from CS Departments in Greece (Kordaki and Berdousis 2017).

According to the curriculum of the Department, in this specific academic period, students had to enroll and successfully be examined in 21 compulsory courses as well as in 25 electives in order to receive the degree. To this end, the grades of the graduates of the period under study, in both compulsory courses and electives were studied and quantitatively-analyzed. In DCS&T, the courses are classified into 3 divisions, namely: 'Theoretical Computer Science' (TCS), 'Software Systems' (SS), 'Computer Technology and Computer Systems' (CTCS). TCS division contains 3 compulsory courses and 11 electives; SS division encloses 8 compulsory courses and 29 electives; while CTCS includes 3 compulsory courses and 15 electives. In addition, for each division 'Math and Physics' (M&P) consisting of 7 courses were compulsory while students were also obligated to select courses from 21 'General Education' (GE) electives.

The procedure followed is described below. The data regarding the 89 graduates were collected from the official records of DCS&T without any reference to the personal data of the graduates apart from their gender. Those data referred to the gender of each graduate, the courses that she/he had enrolled and successfully examined along with her/his grades. Then, a statistical analysis (descriptive and inferential) was realized in terms of: (a) preferences of males and females in each of the elective courses; the percentage of graduates who selected each course were estimated, and (b) performance of males and females in each of the compulsory/elective courses; mean and standard deviation values were calculated and independent sample t-tests were conducted to compare the mean grades of male and female graduates. In terms of methodology, this study can be characterized as a case study (Cohen et al. 2013). The results of the data analysis are presented in the next section.

3. Results

In this section, the results emerged from the data analysis are presented into subsections for each of the above-mentioned 3 divisions as well as for M&P compulsory courses and GE electives. For each one of the aforementioned group of courses, performance (in compulsory courses) as well as preferences and performance in electives are presented in Tables. Specifically, the Tables referring to the performance in compulsory courses presents descriptive statistics - mean grades and standard

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deviation (SD) values - along with the independent samples t test results for the equality of means. As far as the electives are concerns, similar Tables are generated regarding graduates' performance, while for graduates' preferences two more columns are added to present the percentage of graduates (males and females) who selected the corresponding elective. In each of the divisions, graduates' preferences and performance in electives are split into two Tables (a and b), the first of which presents the electives that were selected by a higher percentage of male compared to female graduates, while the second presents the electives that were selected by a higher percentage of female compared to male graduates. All Tables are sorted in a descending order of the mean difference of the grades.

3.1. Graduates' Choices and Performance in "Theoretical Computer Science" courses

TCS Compulsory courses: Graduates' performance

Table 1 illustrates that male graduates achieved higher grades in 'Introduction to the Science & Technology of Informatics' and 'Computational Science' courses compared to females. On the other hand, females performed slightly better in 'Theory of Computation'. Nevertheless, the differences in the mean grades are not statistically significant.

Table 1. Performance in "Theoretical Computer Science" compulsory courses

Graduates' performance in "Theoretical Computer Science" compulsory courses							
Courses	**Group Statistics**				Independent Samples Test - **T test for equality of means**		
	Male		**Female**				
	Mean grade (I)	SD	Mean Grade (J)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Introduction to the Science & Technology of Informatics	7.80	1.26	7.25	1.77	1.289	0.209	0.547
Computational Science I	8.33	1.69	8.10	1.77	0.537	0.593	0.233
Theory of Computation	6.75	1.27	6.83	1.13	-0.249	0.804	-0.078

TCS electives: Graduates' preferences

As it is shown in Table 2a, 4 out of the 10 available electives of the TCS division were chosen more by males. The selected *applied mathematics and theoretical CS course*s ('Operational Research', and 'Combinational Optimization'), the study of *mathematical structures* ('Graph Theory') and other *advanced topics* ('Advanced Topics in TCS').

On the other hand, Table 2b presents that females selected more electives (6 electives) from the TCS division at a higher percentage compared to males. Females preferred more than males the *study of algorithms* ('Computational Geometry', 'Computational Complexity', Parallel algorithms'), the practice and study of *techniques for secure communication* ('Cryptography'), and *computer fractals*. In addition, it is worth noting that 'Computational Science II' was selected from the half of female students (50%) and almost half of the male students (49,28%), while 'Operational Research' was selected from just one female student.

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Table 2a. Preferences and performance in "Theoretical Computer Science" electives: : courses selected more by males

Graduates' preferences and performance in "Theoretical Computer Science" electives									
	Group Statistics						Independent Samples Test - T test for equality of means		
	Preferences		Performance						
	Male	Female	Male		Female				
Courses	graduates who selected the course (%)		Mean grade (I)	SD	Mean grade (I)	SD	t	Sig (2-tailed)	Mean difference (I-J)
Advanced Topics in TCS	23.19	10	8.88	1.18	8.50	0.35	-0.451	0.625	0.38
Combinatorial Optimization	91.30	90	8.31	1.34	8.44	1.28	-0.381	0.704	-0.13
Operational Research	14.49	5	9.50	0.52	10	-	-	-	-0.50
Graph Theory	**15.94**	**10**	**6.18**	**1.53**	**9.25**	**0.35**	**-2.716**	**0.020**	**-3.08***

*The difference is significant at the 0.05 level

TCS electives: Graduates' performance

Concerning the performance of male graduates in these 10 electives of the TCS division, Tables 2a and 2b reveals that they performed better in just 2 courses compared to females. Actually, they performed better in just 1 out of the 4 electives they selected at a higher percentage compared to females. Instead, female graduates performed better in 5 out of the 6 electives they chose more compared to males (Table 2b) and in 8 overall (Tables 2a and 2b). The only female who chose 'Operational research' performed excellent (grade '10'), while in 'Computational Science II', a popular choice for both males and females, the mean grades were exceptionally high. Overall, male graduates performed excellent -mean grade higher than 8,5- in 3 TCS electives: 'Advanced Topics in Theoretical CS', 'Computational Science II' and 'Operational Research', while females performed 'excellent' in the same 3 TCS electives plus 'Graph Theory'.

Nonetheless, the independent sample t-test that was conducted to compare the mean grades of male and female graduates indicated that, actually, there was a statistically significant difference in the mean grade of 'Graph Theory' for males (M=6.18; SD=1.53) and females [M=9.25; SD=0.35; t(11)=-2.716, p=0.02].

Table 2b. Preferences and performance in "Theoretical Computer Science" electives: courses selected more by females

Graduates' preferences and performance in "Theoretical Computer Science" electives									
	Group Statistics						Independent Samples Test - T test for equality of means		
	Preferences		Performance						
	Male	Female	Male		Female				
Courses	graduates who selected the course (%)		Mean grade (J)	SD	Mean grade (J)	SD	t	Sig (2-tailed)	Mean difference (I-J)
Computational Geometry	36.23	60	8.06	1.39	7.88	1.54	0.365	0.717	0.18
Computational Science II	49.28	50	9.20	0.87	9.25	0.72	-0.146	0.885	-0.05
Parallel Algorithms	76.81	90	7.64	1.93	7.69	1.82	-0.102	0.919	-0.05
Computational Complexity	24.64	25	6.91	0.77	7.10	1.02	-0.445	0.661	-0.19
Fractals	27.54	35	7.68	1.31	8.14	1.49	-0.762	0.453	-0.46
Cryptography	14.49	40	6.60	1.50	7.50	1.07	-1.424	0.174	-0.90

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3.2. Students' Choices and Performance in "System Software" (SS) courses

SS compulsory courses: Graduates' Performance

Regarding the compulsory courses of the SS division, Table 3 reveals that male graduates performed better in 6 out of the 8 courses. Nonetheless, the statistical analysis reveals that the only difference that is statistical significant difference is in the mean grade of 'Computer Programming I' for males (M=7.31; SD=1.62) and females [M=6.15; SD=0.99; t (51.509) =3.964, p<0.0001].

Females performed better in 2 compulsory courses with the difference in the mean grades of 'Human Computer Interaction' (Mean difference 0.60 in favor of females) to be statistically significant [t(87)=-1.869; p=0.045]. It is worth noting that, neither males nor females performed excellent regarding these 8 compulsory courses, as there was not a single grade higher than 8.5.

Table 3. Performance in "Software Systems" compulsory courses

Graduates' performance in "Software Systems" compulsory courses							
Courses	**Group Statistics**				Independent Samples Test -		
	Male		**Female**		**T test for equality of means**		
	Mean grade (I)	SD	Mean grade (J)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Computer Programming, I	**7.31**	**1.62**	**6.15**	**0.99**	**3.964**	**0.000**	**1.17****
System Programming	6.14	1.37	5.70	1.02	1.321	0.190	0.44
Data Structures	7.10	1.67	6.70	1.27	0.992	0.324	0.40
Operating Systems	5.89	1.18	5.60	0.94	1.010	0.315	0.29
Object Oriented Programming	7.19	1.61	7.03	1.85	0.386	0.700	0.16
Software Technology	8.04	1.21	8.00	1.50	0.134	0.894	0.04
Database I	6.03	1.01	6.35	1.39	-1.143	0.256	-0.32
Human Computer Interaction	**6.75**	**1.24**	**7.35**	**1.85**	**-1.869**	**0.045**	**-0.60***

*The difference is significant at the 0.05 level
**The difference is significant at the 0.01 level

SS electives: Graduates' Preferences

The courses that were selected from a higher percentage of males compared to females are presented in Table 4a. Male graduates selected at a higher percentage 22 out of the 28 available electives in SS division. Those courses were mainly *core programming courses* (such as 'Java lab', 'C lab', C++ lab', 'Compilers', 'Parallel Programming', 'Theories of Programming Languages', 'Software Engineering', 'Current Software Systems', etc) and *advanced topics of Software Systems* (such as 'Advanced topics in Programming', 'Advanced topics in Software Systems', 'Advanced topics in Database', 'Advanced User Interface').

On the contrary, females selected at a higher percentage, compared to males, 6 out of the 28 electives (see Table 4b). Actually, those 6 courses were about *systems security* ('Systems security') and *data and information management* ('Data and information Visualization', 'Techniques in machine learning & data mining', 'Databases II', 'System Analysis', and 'Information Retrieval'). It is also worth mentioning that very few girls (or none) selected *lab-based courses*, such as 'C Lab', 'Java Lab' and 'C++ Lab' (5%, 0%, 5% respectively).

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Table 4a. Preferences and performance in "Software Systems" electives: courses selected more by males

Graduates' preferences and performance in "Software Systems" electives									
Courses	**Group Statistics**						Independent Samples Test – **T test for equality of means**		
	Preferences		**Performance**						
	Male	**Female**	**Male**		**Female**				
	graduates who selected the course (%)		Mean Grade (I)	SD	Mean Grade (I)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Special topics in software systems	7.25	-	9.8	0.45	-	-	-	-	-
Java Lab	18.84	-	8.85	1.21	-	-	-	-	-
C Lab	33.33	5	8.82	1.43	5.00	-	1.948	0.064	3.82
Data and information Visualization	11.59	5	8.50	2.12	6	-	0.962	0.512	2.50
Info management on the Internet	**31.88**	**25**	**8.6**	**1.11**	**7**	**1.87**	**2.102**	**0.030**	**1.60***
Software Engineering	18.84	5	8.5	1.12	7	-	-	1.000	1.50
Advanced Topics in Database	7.25	5	7.00	1.22	6.00	-	0.745	0.497	1.00
Advanced topics in Soft. Systems	**42.03**	**35**	**9.17**	**0.80**	**8.29**	**1.11**	**2.428**	**0.021**	**0.88***
Current Software Systems	20.29	15	7.18	1.19	6.33	1.15	1.124	0.279	0.85
Multimedia Technology	47.83	40	6.85	1.32	6.00	1.45	1.783	0.093	0.85
Data management systems	50.72	50	7.31	1.42	6.65	1.33	1.321	0.193	0.66
C++ Lab	13.04	5	7.78	1.39	7.5	-	0.189	0.855	0.28
Compilers II	49.28	40	6.57	1.30	6.56	1.89	0.020	0.984	0.01
Distributed Systems	23.19	5	9	0.71	9	-	0.000	1.0	0.00
Advanced topics in Programming	10.14	5	7.5	1.71	7.5	-	-	1.000	0.00
Parallel programming	85.51	80	7.64	1.94	7.69	1.62	-0.102	0.919	-0.05
Advanced User Interfaces, VR	62.32	35	8.74	0.98	9	0.82	-0.654	0.516	-0.26
Artificial Intelligence	82.61	75	7.96	1.47	8.23	1.70	-0.628	0.532	-0.27
Information Systems	49.28	35	7.50	1.46	8.09	1.04	-1.241	0.221	-0.59
Intelligent Systems & Applications	42.03	30	7.50	1.65	8.42	0.92	-1.072	0.291	-0.81
Theories of Prog. Languages	17.39	15	7.18	1.54	8	1.00	-0.859	0.407	-0.82
Database Management Systems	26.09	20	6.67	1.67	7.75	2.63	-1.061	0.301	-1.08

*The difference is significant at the 0.05 level

SS electives: Graduates' performance

Male graduates performed better than females in nearly 60% of the electives they chose at a higher percentage than females (see Table 4a; 13 out of the 22 courses) and more than half of electives in SS overall (see Table 4a and 4b; 16 out of the 28 courses). The differences in the mean grades, in favor of males, that are statistically significant regards: (a) 'Information management on the Internet' [males: M=8.60, SD=1.11; females: M=7, SD=1.87; t(87)=2.102; p=0.030), (b) 'Advanced topics in Software Systems' [males: M=9.17, SD=0.80; females: M=8.29, SD=1.11; t(34)=2.428; p=0.021], and (c) ' Systems Security' [males: M=8.41, SD=1.32; females: M=7, SD=1.56; t(87)=2.345; p=0.023] (see Table,4b).

Female graduates achieved higher mean grades in half of the electives they chose at a higher percentage compared to males (see Table 4b; 3 out of the 6 courses) and in one third of the electives in SS division overall (see Table 4a and 4b; 10 out of the 28 courses). The statistical analysis did not reveal statistical significant differences in favor of females. Finally, males and females performed equally well in 2 electives.

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Table 4b. Preferences and performance in "Software Systems" electives: courses selected more by females

Graduates' preferences and performance in "Software Systems" electives									
Courses	**Group Statistics**						Independent Samples Test - **T test for equality of means**		
	Preferences		**Performance**						
	Male	**Female**	**Male**		**Female**				
	graduates who selected the course (%)		Mean Grade (I)	SD	Mean Grade (I)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Data and information visualization	2.90	5	8.5	2.12	6	-	0.962	0.512	2.50
Systems security	**17.39**	**30**	**8.41**	**1.32**	**7**	**1.56**	**2.345**	**0.023**	**1.41***
Machine learning & data mining	21.74	45	8.33	1.63	7.89	1.62	0.648	0.524	0.44
Databases II	8.70	20	6.03	1.23	6.35	1.54	-0.155	0.881	-0.08
System analysis	52.17	55	7.51	1.48	8.09	1.04	-1.196	0.238	-0.58
Information retrieval	2.90	10	6.5	2.12	7.5	1.41	-0.555	0.635	-1.00

*The difference is significant at the 0.05 level

3.1.3. Students' Choices and Performance in "Computer Technology and Computer Systems" (CTCS) courses

CTCS compulsory courses: Graduates' performance

The performance, in terms of mean grades, of male and female graduates regarding CTCS compulsory courses are illustrated in Table 5. It seems that male students performed slightly better than females in 2 out of the 3 courses while girls had a marginally higher mean grade in "Computer Architecture I" compared to males. Nevertheless, these differences in the mean grades are not statistically significant.

Table 5. Performance in "Computer Technology and Computer Systems" compulsory courses

Graduates' performance in "Computer Technology and Computer Systems" compulsory courses							
Courses	**Groups Statistics**				Independent Samples Test - **T test for equality of means**		
	Male		**Female**				
	Mean grade (I)	SD	Mean grade (J)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Computer Networks I	7.93	1.59	7.85	1.69	0.207	0.836	0.845
Logic Design	7.28	1.48	6.83	1.40	1.212	0.229	0.450
Computer Architecture I	7.16	1.31	7.18	1.35	-0.047	0.963	-0.156

CTCS electives: Graduates' preferences

Male graduates chose at a higher percentage, compared to females, more than half of the available electives of CTCS division (See Table 6a; 9 out of the 15 courses). These courses are about *computer networks issues* ('Advanced Computer Network Issues', 'Digital Signal Processing', 'Computer Communications and Networks II'), *computer engineering* ('Synthesis of Digital Architectures', 'Computer arithmetic', 'Computer organization', 'Introduction to Hardware Description Languages', and 'Introduction to embedded systems') and 'Robotics'.

Regarding female graduates' choices, they selected at a higher percentage, compared to males, 6 out of the 15 electives (see Table 6b), mainly concerning *computer architecture* ('Advanced Computer Architectures', 'Computer Architecture II', 'Hardware description languages II', 'Digital circuit design'), *coding* and *mobile communication* ('Information theory and coding' and 'Wireless and Mobile Communications'). Nevertheless, one third of the electives of CTCS division were not selected by any of the female graduates (see Table 6a; 5 out of the 15 courses), that were about *computer engineering*

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('Synthesis of digital architectures', 'computer arithmetic'), *robotics* ('Robotics') and *computer network issues* ('Digital signal processing' ''Advanced Computer Network Issues'). Correspondingly, 4 out of the 15 available electives were selected by just one male (see Table 6a and 6b).

Table 6a. Preferences and Performance in "Computer Technology and Computer Systems" electives: courses selected more by males

Graduates' preferences and performance in "Computer Technology and Computer Systems" electives									
Courses	**Group Statistics**						Independent Samples Test - **T test for equality of means**		
	Preferences		**Performance**						
	Male	**Female**	**Male**		**Female**				
	graduates who selected the course (%)		Mean Grade (I)	SD	Mean Grade (I)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Advanced Computer Network Issues	11.59	-	8.25	1.10	-	-	-	-	-
Robotics	5.80	-	8.5	2.38	-	-	-	-	-
Synthesis of Digital Architectures	2.90	-	8.5	2.12	-	-	-	-	-
Digital Signal Processing	1.45	-	6	-	-	-	-	-	-
Computer arithmetic	1.45	-	7	-	-	-	-	-	-
Introduction to embedded systems	20.29	10	8.29	1.38	8.25	2.47	0.032	0.975	0.04
Hardware Description Languages	55.07	55	7.09	1.63	6.59	1.39	0.926	0.359	0.50
Computer Networks II	10.14	5	6.93	2.07	7	-	-0.032	0.975	-0.07
Computer organization	91.30	70	8.10	1.43	8.25	1.42	-0.348	0.729	-0.15

CTCS electives: Graduates' performance

Male graduates performed slightly better compared to females in 3 electives, apart from those electives that they were selected just by males. However, the mean differences in those cases are not statistically significant. Interestingly, male graduates performed exceptionally well in the electives that were not selected by females, and excellent in "Robotics" and "Synthesis of Digital Architectures".

On the other hand, female graduates achieved higher mean grades than males in 7 electives. The statistical analysis indicated that the difference in the mean values is statistically significant in the case of 'Information theory and coding' [males: M=5.65, SD=0.95; females: M=6.69, SD=1.46; t(34)=-2.148; p=0.042]. An inspection of the mean grades reveals that there are several courses that females perform actually well. All in all, except the previously mentioned course, it seems that male and female graduates performed equally well in the electives of CTCS division.

Table 6b. Preferences and Performance in "Computer Technology and Computer Systems" electives: courses selected more by females

Graduates' preferences and performance in "Computer Technology and Computer Systems" electives									
Courses	**Group Statistics**						Independent Samples Test - **T test for equality of means**		
	Preferences		**Performance**						
	Male	**Female**	**Male**		**Female**				
	graduates who selected the course (%)		Mean Grade (I)	SD	Mean Grade (I)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Advanced Computer Architectures	23.19	35	7.13	1.02	7	0.82	0.284	0.779	0.13
Digital circuit design	30.43	**35**	8.45	1.40	8.57	1.10	-0.205	0.839	-0.12
Hardware description languages II	14.49	**30**	8.85	1.18	9.17	0.75	-0.585	0.568	-0.32
Computer Architecture II	1.45	5	6	-	7	-	-	-	-1.00

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Information theory and coding	**24.64**	**40**	**5.65**	**0.95**	**6.69**	**1.46**	**-2.148**	**0.042**	**-1.04***
Wireless & Mobile Communications	1.45	10	5	-	8	0.00	-	-	-3.00

*The difference is significant at the 0.05 level

3.1.4 Graduates' Performance in "Mathematics & Physics" (M&P) courses

The analysis of the grades of the graduates in M&P courses (see Table 7) reveals that male graduates performed better than females in 5 out of the 6 Math courses whereas in "Physics I" female graduates had a higher mean grade. The independent sample t-test that was conducted to compare the mean grades of male and female graduates in M&P courses indicated that there were statistically significant differences in the mean grades of 2 courses: (a) Linear Algebra [males: M=6.44, SD=1.31; females: M=5.55, SD=1.06; t(87)=2.782; p=0.007], and (b) Mathematics I [males: M=6.59, SD=1.43; females: M=5.98, SD=1.27; t(87)=1.728; p=0.048]. Yet, both male and female graduates achieved mean grades in all M&P courses which are far from 8.5 ("Excellent").

Table 7. Performance in "Mathematics & Physics" compulsory courses

Graduates' Performance in "Mathematics & Physics" compulsory courses							
Courses	**Groups Statistics**				Independent Samples Test - **T test for equality of means**		
	Male		**Female**				
	Mean grade (I)	Std. Deviation	Mean grade (J)	Std. Deviation	t	Sig. (2-tailed)	Mean Difference (I-J)
Linear Algebra	**6.44**	**1.31**	**5.55**	**1.06**	**2.782**	**0.007**	**0.89***
Prob. Theory & Statistics	7.14	1.84	6.45	1.68	1.500	0.137	0.69
Mathematics I	**6.59**	**1.43**	**5.98**	**1.27**	**1.728**	**0.048**	**0.61***
Arithmetic Analysis	7.10	1.58	6.60	1.47	1.265	0.209	0.50
Mathematics II	6.33	1.58	6.13	1.61	.518	0.606	0.21
Physics I	7.28	1.83	7.38	1.89	-.213	0.832	-0.10
Discrete Mathematics	6.20	1.05	6.63	1.06	-1.581	0.117	-0.42

*The difference is significant at the 0.05 level

3.1.5. Graduates' Preferences and Performance in "General Education" (GE) electives

GE electives: Graduates' preferences

Electives in GE cover a wide range of subjects that can be applied to many different careers and students can choose them according to their interests. Table 8a reveals that 6 out of the 20 electives in GE were selected at higher percentage from males compared to females. Apart from the *foreign languages* ('English', and 'French'), males preferred the *study of mathematical models* ('Game Theory'), and the *marketing and management perspective* of informatics ('New product and service development', 'Economic Science I').

As it is derived from Table 8b, two third of the electives, 14 out of the 20 courses, were selected by a higher percentage of females compared to males. These courses regard *Humanities and Social Sciences* ('Social and Professional Issues', 'Computers and Education', 'Sociology', 'Psychology', 'Teaching of Informatics', 'Pedagogy', 'Philosophy', 'Cognitive Science'), *CS terminology* ('English Terminology', 'French Terminology'), *CS career opportunities* ('Banking IT') and *mathematics* ('Differential Equation'). It is worth noting that very few females (in some cases, none at all) choose: "Introduction to the Economic Science I & II", "Game Theory", "Legal issues in informatics", "French" and "New product and service development", whereas the only elective course that was not selected by males was "Introduction to the Economic Science II".

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Table 8a. Preferences and Performance in "General Education" electives: courses selected more by males

Graduates' preferences and performance in "General Education" electives									
	Group Statistics						Independent Samples Test - T test for equality of means		
	Preferences		Performance						
Courses	Male	Female	Male		Female				
	graduates who selected the course (%)		Mean Grade (I)	SD	Mean Grade (I)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Introduction to Economic Science I	11.59	-	7.07	1.39	-	-	-	-	-
Legal issues in informatics	10.14	5	9.57	0.79	8	-	2.008	0.091	1.57
Game theory	5.80	5	7.12	1.93	6	-	0.521	-	1.12
English	92.75	80	6.60	1.07	6.38	1.48	0.671	0.504	0.22
French	5.80	5	8.63	1.11	9	-	-0.303	0.782	-0.37
New product & service development	8.70	5	9.50	0.54	10	-	-0.845	0.437	-0.5

GE electives: Graduates' performance

Male graduates performed better, compared to females, in 9 electives. In fact, they performed better in 4 out of the 6 electives the selected more. The statistical analysis reveals that there was a statistically significant difference in the mean grades of males and females in 'Social and Professional Issues' [males: M=8.46, SD=1.20; females: M=5.80, SD=1.10; t(87)=4.310; p=0.001

Likewise, female graduates performed better, compared to males, in 9 electives. The statistical analysis also reveals that there was a statistically significant difference in the mean grades of females and males in 'Differential Equation' [males: M=7.31, SD=1.91; females: M=8.67, SD=1.78; t(87)=-1.987; p=0.047. There are also 2 electives that both male and female students have almost same mean grades ('Pedagogy' and 'Sociology').

All in all, an inspection of the mean grades reveals that males' and females' performance in GE electives was remarkable. In fact, male graduates performed excellent (mean grade equal or higher than 8.5) in 7 GE electives, while females had a mean grade greater than 8,5 in 11 elective courses. 4 of these courses are common for both male and female students.

Table 8a. Preferences and Performance in "General Education" electives: courses selected more by females

Graduates' preferences and performance in "General Education" electives									
	Group Statistics						Independent Samples Test - T test for equality of means		
	Preferences		Performance						
Courses	Male	Female	Male		Female				
	graduates who selected the course (%)		Mean Grade (I)	SD	Mean Grade (I)	SD	t	Sig. (2-tailed)	Mean Difference (I-J)
Introduction to Economic Science II	-	5	-	-	5	-	-	-	-
Social and Professional Issues	**18.84**	**25**	**8.46**	**1.20**	**5.8**	**1.10**	**4.310**	**0.001**	**2.66***
English Terminology	94.20	100	7.30	1.24	6.87	1.23	1.339	0.184	0.43
Computers and Education	27.54	30	8.05	1.18	8.50	1.22	-0.804	0.429	0.55
History of Computers	73.91	80	8.06	1.07	7.81	1.22	0.778	0.439	0.25
Pedagogics	68.12	90	7.13	1.74	7.14	1.53	0.022	0.983	0.01
Sociology	27.54	50	8.63	1.38	8.60	1.89	0.051	0.959	0.03
Didactics of Informatics	20.29	25	8.86	0.66	9	1.41	-0.218	0.837	-0.14
Cognitive Science	11.59	25	9	1.30	9.80	0.45	-1.301	0.22	-0.80

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Psychology	34.76	55	7.79	1.44	8.63	1.14	-1.706	0.097	-0.84
Management Information Systems	13.04	35	8.40	1.14	9.25	0.96	-1.189	0.273	-0.85
Banking IT	11.59	25	7.63	1.89	8.60	0.82	-1.281	0.228	-0.97
Differential Equation	**42.03**	**45**	**7.31**	**1.91**	**8.67**	**1.78**	**-1.987**	**0.047**	**-1.36***
Philosophy	14.49	20	7.10	2.13	9.25	1.50	-1.824	0.093	-2.15

*The difference is significant at the 0.05 level

4. Discussion

The analysis of the data reveals interesting finding in terms of CS graduates', (a) preferences and (b) performance.

CS Graduates' preferences

It seems that male graduates selected courses mainly from the 'Software Systems' and 'Computer Technology and Computer Systems' divisions. Actually, they selected at a higher percentage compared to females, *core programming electives* and *advanced topics of Software Systems*. Males also preferred electives regarding *computer network issues*, *computer engineering* and *robotics*. From the Theoretical Computer Science division, they preferred *applied mathematics and theoretical CS courses*, the study of *mathematical structures* and other *advanced topics*. General Education electives were not popular among male students, compared to females. Males seem to prefer more *foreign language courses*, as well as the *study of mathematical models*, and the *marketing and management perspective* of informatics. This fact is in accordance with the findings of relevant studies in STEM fields, which support that males take mathematics, engineering, CS, and physical sciences in higher numbers compared to females (Kenway and Gough 1998; Bussey and Bandura 1999; Coley, 2001; Amelink 2009).

On the other hand, females preferred more 'Theoretical Computer Science' electives than males did, and specifically the *study of algorithms*, the practice and study of *techniques for secure communication*, and computer *fractals*. The electives that females preferred more than males did from the Software Systems division were about *systems security* and *data and information management*, while the *lab-based* electives was not their choice. Moreover, females selected more than males did electives regarding *computer architecture*, *coding* and *mobile communication*. Nevertheless, females did not select almost one third of the electives of Computer Technology and Computer Systems division, which were about *computer engineering, robotics* and *computer network issues*. However, females preferred electives from the 'General Education' category that concern *humanities and social sciences*, *CS terminology*, and *CS career opportunities*.

CS Graduates' performance

Male graduates performed better – but not statistically significant – than females in the majority of compulsory courses in all of the aforementioned 3 divisions, as well as 'Mathematics'. Actually, they performed better in 15 out of the 21 compulsory courses of the curriculum of the Department, while the differences in the mean grades that reach *statistically significance*, in favor of males, concerned one core programming course, '*Computer Programming I*', and two Mathematics courses, '*Linear Algebra*', and '*Mathematics I*'. Despite their better performance in compulsory courses, males did not perform equally well in electives. In fact, they performed better in half of the available electives overall (37 out of the 73 available electives). Interestingly, they performed better than females in more electives of the Software Systems division, with 3 of these differences of the mean grades are *statistically significant* in the following courses: '*Information management on the Internet*', '*Advanced Topics in Software Systems*', '*System Security*'. Males' performance in Theoretical Computer Science electives, compared to females, was not outstanding. Even in those courses they had selected at a higher percentage compared to females, their mean grades were not higher than females'. Nevertheless, male graduates performed exceptionally well in the electives they selected from the 'Computer Technology and Computer Systems' division, and especially in those courses that were not selected by females at all, like '*Robotics*' and '*Synthesis of Digital Architectures*' where males performed excellent. Moreover, male graduates performed better than females in those General Education

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electives they selected more. Those courses covered a variety of issues regarding CS, like '*Game Theory*', and the *connection of CS with the real life*, like economy, social and professional issues. In fact, the difference in the mean grades of '*Social and Professional Issues'* were statistically significant, in favor of males.

By contrast, females performed better in 6 out of the 21 compulsory courses. Apart from 'Physics', the rest 5 courses are distributed in the 3 divisions, thus, there is not a clear tendency. Nevertheless, in Software System division, the difference in the mean grades, in favor of females, in '*Human Computer Interaction*', is statistically significant. It is worth noting that females' mean grades in Math courses were really low (not over 6.6), while in *Physics* they achieved mean grade higher than males'. Despite the lower mean grade in most of the compulsory courses, female graduates performed equally well, or even better, in electives. Specifically, females performed better in more 'Theoretical Computer Science' electives compared to males, especially those they selected at a higher percentage. It is worth mentioning that, the difference between males' and females' mean grade in *'Graph Theory'* is statistically significant in favor of females. Regarding 'Software Systems' electives, females performed better in *computer systems applications* courses, yet these differences are not statistically significant, thus, they cannot be generalized. Moreover, females achieved lower mean grades than males in the majority of the 'Computer Technology and Computer Systems' electives, but these differences were not statistically significant, except the mean values in the case of '*Information theory and coding'* which are statistically significant in favor of females. Concerning General Education electives, females performed actually well, achieving excellent mean grades in 11 electives regarding *Humanities* and *Social Sciences* as well as areas connected with *real and professional life*. Nevertheless, the only statistically significant difference –in favor of females- in General Education electives concerned '*Differential Equation*'. Overall, the analysis of the data revealed that there were a few significant differences in the performance of males and females in specific CS courses, indicating that the myth about actual gender differences in cognitive skill and academic ability is non-existent. This finding is in line with relevant studies in STEM fields (Ding 2006; Kiran and Sungur 2012; Alkhadrawi 2015), supporting that when different domains are taken into consideration, females perform better than males on the social aspects of science factors and males tend to perform better than females on the constructs of science factors (Kiran and Sungur 2012).

6. Conclusions

This study focused on the investigation of gender issues in terms of undergraduates' preferences and performance in CS undergraduate courses. For the purpose of this study, data from 89 degrees earned from CS students – during a 6-year period of graduation at the Department of CS and Technology, University of Peloponnese, Greece – were quantitatively analyzed.

The data analysis revealed that there were different preferences among male/female CS graduates, that is in line with relevant evidence from other STEM fields (Bussey and Bandura 1999; Coley, 2001; Amelink 2009). In fact, males preferred more than females did *core programming courses* and *advanced topics of Software Systems*, as well as courses related to *computer networks*, *computer engineering, robotics and courses related to mathematics*. In addition, males selected more courses related to the *marketing and management perspective* of CS. By contrast, females preferred more the study of *algorithms* and the courses related to security issues, as well as computer *fractals,* and *data and information management*, as well as *computer architecture*, and *mobile communication*. Females also preferred courses regarding *humanities and social sciences*, *CS terminology*, and *CS career opportunities*, in which they performed excellent. However, it is worth mentioning that, females did not select at all *programming lab-based* courses, *computer engineering, computer network issues and robotics.*

In terms of performance, at first glance, it seems that males performed better than females in the majority of the compulsory courses and some of the electives, especially regarding Systems Software and Computer Technology & Computer Systems, yet the differences in the mean grades are not statistically significant. Though, males performed significantly better than females in one core programming course and two mathematics courses, as well as, in three electives concerning Software Systems. The performance of males in Computer Technology and Computer Systems courses were

outstanding, especially in those electives that were not selected by females, while they actually performed significantly better than females in *Social and Professional Issues.* On the other hand, females' performance in the Theoretical Computer Science electives they selected more was remarkable, and they performed significantly better than males in Graph Theory. Despite the higher means in *computer systems applications* courses compared to males, these differences are not statistically significant, apart from Human Computer Interaction elective where females performed significantly better than males. Like males, females' grades in Mathematical courses were not high, in contrast to courses related to *Humanities* and *Social Sciences* and *real and professional life* where they performed excellent. In addition, females achieved significantly higher mean grade in *Differential Equations*, an elective course that females selected at a higher percentage. On the whole, it seems that in terms of performance there are no significant differences between the mean grades of males and females in most of the CS courses. Any statistically significant differences in performances were present in almost equal number of courses in favor of males and females. In this sense, striking differences in performance in CS, like other STEM fields (Ding 2006; Kiran and Sungur 2012; Alkhadrawi 2015), are not observed, and any difference in CS are not differences in skills or ability but are actually socially constructed 'myths' that constitute obstacles that hinder female success.

Limitations of the study: Although some of the results are in line with the findings of other studies, this study refers to a certain period of time as well as a particular CS Department in Greece with a specific curriculum and degree requirements. Any generalization of these results should be undertaken with caution and be limited to countries and CS Departments that have similar characteristics to those of the participants in this study. Any research findings differing from those of other studies should be handled with the same prudence.

Implications of the study: The findings of the current study have not only shown implications for the males' and females' performance, but they have also provided information about the gender gap regarding course preferences. The absence of actual significant differences in the performance of male and female graduates seems to deconstruct the myth that there are actual differences in cognitive skills and academic ability in CS, which, in some cases constitute obstacle that hinder female participation and success in the field. Nevertheless, keeping in mind that those myths have actual social implications, this study can contribute to the field of CS curriculum and instruction by determining to what extent more effort is needed in the education system to dispel gender myths and remove perceived boundaries within certain CS career paths. Consequently, this study could lead to the incorporation of teaching strategies to challenge persistent myths, about gender differences in CS performance, and perceived obstacles about gender and CS. Moreover, it is hoped that this study provides useful insights about the preferences of males and females in CS, triggering an effort for the adjustment of the CS curriculum and instruction by CS teachers in order to adjust the context of CS to the preferences and the interests of females as well.

Future research dimensions: This study yields interesting research prospects. An investigation of the CS teachers' beliefs about the gender gap in CS and the differences between males and females may uncover the presence, or the absence, of the myth of gender differences in CS education. Subsequently, CS teachers and students can be informed about the absence of actual differences in the performance of males and females in CS in order to be aware of the socially constructed myth and the fact that any differences are not differences in ability or skills. In fact, this is next item in the authors' research agenda. Additionally, educational programs that take into consideration males' and females' preferences in CS can be designed, implemented and evaluated by CS teachers in secondary education and CS departments in tertiary education in order to render every aspect of CS interesting, appealing and fascinating for both males and females.

7. Materials and Methods

The materials and the method followed are described in detail in the 'Context of the study' section. The data were retrieved from the official records of DCS&T without any reference to the personal data of the graduates apart from their gender.

Author Contributions: Ioannis Berdousis and Maria Kordaki both participated in designing the study, analyzing data, and writing the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

References

(Adelman 1991) Adelman, C. (1991). *Women at thirtysomething: Paradoxes of attainment.* Washington, DC: U.S. Department of Education, Office of Educational Research and Development.

(Alkhadrawi 2015) Alkhadrawi, A. (2015). *Gender Differences in Math and Science Choices and Preferences* (Doctoral dissertation). The University of Toledo.

(Amelink 2009) Amelink, C. (2009). *Literature overview: Gender differences in science achievement*. SWE-AWE-CASEE ARP Resources – Gender Differences in Science Performance. Retrieved from http://www.AWEonline.org.

(Ashcraft et al. 2012) Ashcraft, C., Eger, E. and Friend, M. (2012). *Girls in IT: The Facts*. Boulder, CO: National Center for Women & Information Technology.

(Barker and Aspray 2006) Barker, L. J., and Aspray, W. (2006). The state of research on girls and IT. In J.M. Cohoon & W. Aspray (Eds.), *Women and Information Technology: Research on Underrepresentation*, (pp. 3-54). Cambridge: MIT Press.

(Berdousis and Kordaki 2016) Berdousis, I., and Kordaki, M. (2016). Computing and STEM in Greek Tertiary education: gender representation of faculty members during the decade 2003–2013. *Gender and Education*, DOI: 10.1080/09540253.2016.1156653.

(Britner 2008) Britner, S. L. (2008). Motivation in high school science students: A comparison of gender differences in life, physics, and earth science classes. *Journal of Research in Science Teaching, 45*(8), 955–970.

(Bussey and Bandura 1999) Bussey, K., and Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review, 106*, 676–713.

(Camp 2012) Camp, T. (2012). 'Computing, we have a problem…'. *ACM Inroads, 3*(4), 34-40.

(Cheryan et al. 2009) Cheryan, S., Plaut, V. C., Davies, P. G., and Steele, C. M. (2009). Ambient belonging: How stereotypical cues impact gender participation in computer science. *Journal of Personality and Social Psychology, 97*(6), 1045-1060.

(Cheryan et al. 2015) Cheryan, S., Master, A., and Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes. *Front. Psychol. 6*(49). doi: 10.3389/fpsyg.2015.00049.

(Cohoon and Aspray 2006) Cohoon, J.M., and Aspray, W. (Eds.). (2006). *Women and Information Technology: Research on Underrepresentation*. Cambridge: MIT Press.

(Coley 2001) Coley. R. J. (2001). *Differences in the gender gap: Comparisons across racial/ethnic groups in education and work*. (ETS Policy Information Report). Princeton, NJ: Educational Testing Service.

(Cunningham et al. 2015) Cunningham, B. C., Hoyer, K. M., and Sparks, D. (2015). Gender Differences in Science, Technology, Engineering, and Mathematics (STEM) Interest, Credits Earned, and NAEP Performance in the 12th Grade. Stats in Brief. NCES 2015-075. *National Center for Education Statistics*.

(Cunningham 2007) Cunningham, C. (2007). *Implications of recent contributions to research on K-12 engineering and technology education on STEM education*. 2007 DR-K12 PI Meeting, Arlington, VA.

(Ding et al. 2006) Ding, C. S., Song, K., and Richardson, L. I. (2006). Do mathematical gender differences continue? A longitudinal study of gender differences and excellence in mathematics performance in the U.S. *Journal of the American Educational Studies Association*, 279–295. doi:10.1080/00131940701301952.

(Freedman 2002) Freedman, M. P. (2002). The influence of laboratory instruction on science achievement and attitude toward science among ninth grade students across gender differences. *Journal of Women and Minorities in Science and Engineering, 8*(2).

(Gürer and Camp 2002) Gürer, D., and Camp, T. (2002). An ACM-W literature review on women in computing. *ACM SIGCSE Bulletin, 34*(2), 121-127.

(Haussler and Hoffmann 2002) Haussler, P., and Hoffmann, L. (2002). An intervention study to enhance girls' interest, self-concept, and achievement in physics classes. *Journal of Research in Science Teaching, 39*(9), 870–888.

(Hill et al. 2010) Hill, C., Corbett, C., and St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics*. Washington, DC: AAUW.

(Hyde et al. 1990) Hyde, J., Fennema, E., and Lamon, S. J. (1990). Gender differences in Mathematics performance: A meta-analysis. *Psychological Bulletin, 107*(2), 139–155.

(Jacobs 2005) Jacobs, J. E. (2005). Twenty-five years of research on gender and ethnic differences in STEM career choices: What have we learned? *New Directions for Child and Adolescent Development, 110*, 85–94.

(Jacobs et al. 2002) Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., and Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*(2), 509–527.

(Kenway and Cough 1998) Kenway, J., and Gough, A. (1998). Gender and science education in schools: A review 'with attitude'. *Studies in Science Education, 31*, 1–30.

(Kiran and Sungur 2012) Kiran, D., and Sungur, S. (2012). Middle school students' science self-efficacy and its sources: examination of gender differences. *Journal of Science Education Technology, 21*(5), 619–630.

(Cohen et al. 2013) Cohen, L., Manion, L., and Morrison, K. (2013). *Research methods in education*. Routledge.

(Kordaki and Berdousis 2017) Kordaki, M., and Berdousis, I. (2017). Computing and STEM in Greece: Gender representation of students and teachers during the decade 2002/2012. *Education and Information Technologies*, 22(1), 101-124.

(Laird et al. 2009) Laird, J., Alt, M., and Wu, J. (2009). *STEM Coursetaking Among High School Graduates, 1990–2005* (ED-05- CO-0053). Berkeley, CA: MPR Associates

(Margolis and Fischer 2003) Margolis, J., and Fisher, A. (2003). *Unlocking the clubhouse: Women in computing*. MIT press.

(Marion and Coladarci 1993) Marion, S. F., and Coladarci, T. (1993). *Gender Differences in Science Course-Taking Patterns among College Undergraduates*. Paper presented at the Annual Meeting of the American Educational Research Association, Atlanta, GA.

(Matthews et al. 2009) Matthews, J. S., Pontiz, C., and Morrison, F. J. (2009). Early gender differences in selfregulation and academic achievement. *Journal of educational psychology, 101*(3), 689-704

(Meece and Courtney 1992) Meece, J. L., and Courtney, D. P. (1992). Gender differences in students' perceptions: Consequences for achievement-related choices. In D. Schunk & J. Meece (Eds.), *Student perceptions in the classroom* (pp. 209–228). Hillsdale, NJ: Lawrence Erlbaum Associates.

(Mickelson 1989) Mickelson, R. A. (1989). Why does Jane read and write so well? The anomaly of women's achievement. *Sociology of Education, 62*, 47–63.

(O'Reilly and McNamara 2007) O'Reilly, T., and McNamara, D. S. (2007). The impact of science knowledge, reading skill, and reading strategy knowledge on more traditional 'high stakes' measures of high school students' science achievement. *American Educational Research Journal, 44*(1), 161–197.

(Ormrod 2007) Ormrod, J. E. (2007). *Educational psychology: Developing learners* (6th ed.). Upper Saddle River, NJ: Prentice Hall.

(Santrock 2008) Santrock, J. (2008). *Educational psychology* (4th ed.). New York: McGraw-Hill.

(Saunders et al. 2004) Saunders, J., Davis, L., Williams, T., and Williams, J. H. (2004). Gender Differences in Self-Perceptions and Academic Outcomes: A Study of African American High School Students. *Journal of Youth and Adolescence, 33*(1), 81–90.

(Van de Gaer et al. 2008) Van de Gaer, E., Pusjens, H., Damme, J., and De Munter, A. (2008). Mathematics participation and Mathematics achievement across secondary school: The role of gender. *Sex Roles, 59*, 568–585.